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AN INVESTIGATION OF THE NEED FOR FORMALIZED TRAINING OF FACILITY MAINTENANCE PERSONNEL

JAMES C. DAY, JR.
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AN INVESTIGATION OF THE NEED FOR FORMALIZED TRAINING OF FACILITY MAINTENANCE PERSONNEL

by

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Submitted in fulfillment of the
requirements for the course

INDIVIDUAL RESEARCH
MN - 400

United States Naval Postgraduate School
Monterey, California

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ABSTRACT

This research paper is the result of an investigation of the need for formalized training of facility maintenance personnel in the Naval Shore Establishment. The need for increased craftsmen productivity is developed from an analysis of the physical composition of facilities, backlog of essential maintenance and funding. Past and present organizational and management methods to increase productivity are explained. A historical analysis of apprenticeship is developed to show that the present national shortage of craftsmen is but the latest of a periodic reoccurring shortage. A description of present required craftsmanship training procedures in the Navy is also provided.

The above factors, that affect in various ways the quality and quantity of craftsmen required, act as a framework from which to view the major undertaking of this investigation. This was a nationwide survey of the status of facilities maintenance craftsmenship at Naval activities. Data was accumulated with respect to age distributions, attrition rates, methods of recruitment, classifications, and the types of training available. Subjective comments concerning the above were also collected. A comparative analysis of this information was conducted with equivalent data. Developed on the same categories of craftsmen used by private and construction industries. Information was collected by review of the literature, questionnaires, correspondence and personal interviews.

The findings of the investigation indicated a serious problem in both the immediate future and over the long run unless corrective measures are taken. The direction of these measures are presented as recommendations.

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SECTION I

STATEMENT OF THE PROBLEM

I. BACKGROUND

The physical facilities of the Naval Shore Establishment would currently cost over twenty billion dollars to replace.[1] Eighty five percent of these were built during or before the Korean War and more than half of the Navy's buildings are overage or obsolescent.[2] Age, however, is not the only concern. Tremendous technological changes have occured since 1950 which have demanded new services from the existing facilities. Built for other purposes, the facilities are often hard pressed to provide these services.

Current funding is not sufficient to support an adequate level of maintenance or halt the growth of the maintenance backlog. Thus age and inadequate maintenace are producing an unsatisfactory state of readiness of naval facilities.

The performance of this maintenance, for the most part, is accomplished by craftsmen of the building and construction trades employed in Public Works Activities of the Navy throughout the world.

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[1] Projected from 1961 data from the Department of the Navy, Facilities, Management Study, Vol. 11, 26 October, 1962. p. 97.

[2] Stated by a Bureau of Yards and Docks representative during a management seminar address at the District Public Works Office, San Bruno, California, January, 1964.

Much progress has been and is being made in increasing the effectiveness of their efforts organizationally and procedurally.[3] What is being done to increase their productivity as individuals? It is generally recognized that productivity is correlated with the degree and type of training received. This applies to both initial training of a skill and the periodic updating of that skill--especially in this age of technological evolution.

The Chief of the Bureau of Yards and Docks, who is responsible for the maintenance of the Naval Shore Establishments, stated on 14 February, 1964:

> "In the past we have had a tendency to train people on a catch as catch can basis. If somebody is available we send them off to a course or give them some special training."

Initial training, of course, is not a problem if it is possible to directly hire craftsmen already trained--when, where and in the numbers required. There is no such easy solution to updating skills.

II. THE PROBLEM

The problem with which this investigation is principally concerned is solved in the development of answers to the following four questions:

1. To what extent are Public Works Activities able to hire facility maintenance craftsmen, already trained-when, where and in the numbers required at the present?

2. What will the Navy's need for such craftsmen be in

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[3] See Section III, p 13.

the immediate future (the next five years) and in the long run (the next forty-five years)?

3. What problems can be expected in procuring such craftsmen from labor markets in the immediate future and the long run?

4. To what extent does the Navy presently provide formalized training, both initially through apprenticeship programs and periodically through skill updating programs, for facility maintenance personnel in Public Works Activities?

III. DEFINITION OF KEY TERMS

The very nature of this investigation requires terms which may be peculiar to the Naval Shore Establishment, to the construction industry, to education, and to personnel management specialists. In order, however, to make this investigation as meaningful as possible to those unfamiliar with these several fields, special terms and phraseology are avoided where possible. Where unavoidably used they are explained in their context or by appropriate footnotes, thus eliminating a formal explanation of terms at this point.

Throughout the paper there is a degree of repetitive mention of various naval directives, offices or agencies. Such names will be spelled out in full when first introduced and immediately followed by the letter abbreviation. Thereafter the abbreviation will be used in the interest of brevity.

IV. LIMITATIONS

This study is not intended to produce a handbook of quick, effortless and inexpensive techniques of how to formally train competent facility maintenance craftsmen. Rather, it will attempt to establish if a real need for formalized training exists now or can be expected to exist in the future.

This study is limited to facility maintenance personnel due to the evolution of an excellent facilities maintenance management program; the consolidation of Public Works Activities; and, most recently, the assignment of facility maintenance funds--Navy wide-- to the Bureau of Yards and Docks (BUDOCKS). All of these organizational, fiscal and management changes assigns, for the first time, to one Bureau both the responsibility and authority to provide the proper training to those personnel who carry out the Bureau's mission with respect to maintenance of the Shore Establishment's physical facilities.

It is the belief of the writers that development of formalized training programs can not and should not be attempted until the existance and magnitude of the need are known. The purpose of this study is to provide such information.

SECTION II

METHODS, MATERIALS, TECHNIQUES AND PROCEDURES

I. INITIAL INVESTIGATION

Initial study in connection with this paper was directed at determining what efforts were being made at present by the Navy to increase the productivity of facility maintenance personnel. This was accomplished through a review of current Navy facilities management studies, standard maintenance management manuals of BUDOCKS, and finally, through officially promulgated policy statements in this field of study. Although much progress was evident on current methods to improve productivity, (See Section III, Page 14), no information was available on current attempts to procure formally trained personnel or update their skills once hired.

II. QUESTIONNAIRE

A questionnaire, (See Figures 1 and 2, Pages 6 and 7), was prepared and with a letter of transmittal was forwarded to one hundred and sixty two activities. Navy and Marine Corps activities, located within the continental United States and Hawaii, with a Public Works Officer assigned, were selected.[4] The information requested and the purpose was as follows:

1. The total number of journeymen[5] employed. This

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[4] Activities solicted were selected through the use of the Bureau of Yard and Docks, Civil Engineer Corps Directory, NAVDOCKS P-1, May 1963.

[5] The term "journeymen" is used interchangeably in the trades with "skilled craftsmen." Within the Navy, the term journeymen is used almost exclusively. By definition, either means, "One who has served an apprenticeship."

Activity______________________________

Location______________________________

NUMBER

1. Total Journeymen Employed: ______

2. Grouped By Age:

   20 to 24 years ______
   25 to 29 years ______
   30 to 34 years ______
   35 to 39 years ______
   40 to 44 years ______
   45 to 49 years ______
   50 to 54 years ______
   55 to 59 years ______
   60 years and over ______

3. Anticipated Journeymen Losses Due to All Causes:
   (Based on past attrition and future projections)

   Fiscal Year 1965 ______
   Fiscal Year 1966 ______
   Fiscal Year 1967 ______
   Fiscal Year 1968 ______
   Fiscal Year 1969 ______

4. Total Journeymen By Specific Trade:

   Electrician ______
   Carpenter ______
   Painter ______
   Plumber ______
   Other (list on back side) ______

Fig. 1 - Apprenticeship and Skill Updating Questionnaire

5. Do you have a certified apprentice program? ______

If so, in which trades and for what duration

Trade______________________ Duration___________years

Trade______________________ Duration___________years

Trade______________________ Duration___________years

6. Do you have a skill updating program? ______

If so, in which trades and for what duration

Trade______________________Duration____________months

Trade______________________Duration____________months

Trade______________________Duration____________months

Is skill updating available through a:

Local School (trade, high, or college) ______

Local manufacturer of industry ______

Local activity ______

Other ______

7. Present method of recruiting journeymen

(Rate 1, 2, 3, or 4)

Activity Apprenticeship Program ______

Outside hire of certified journeymen ______

Activity promotion of helper classification ______

Outside hire of those with experience but no formal training ______

Fig. 2 - Apprenticeship and Skill Updating Questionnaire (cont'd)

information was necessary to determine the total number of personnel included in the replies; to verify sub-totals of other information; and to determine the correlation between the size of activity and number of journeymen employed.

2. The number of journeymen by age groups in five year increments--starting at age twenty[6] and ending at sixty years and older--a total of nine age groups. The purpose of this information was to determine the long run replacement needs of the Navy; to determine if the population was evenly distributed by age group and if not, approximately when a serious problem could be expected.

3. The anticipated number of journeymen losses due to retirement, disability, resignations, disciplinary action, deaths, and other causes. To prevent guessing, it was requested that the data be based on previous years statistics. The data was requested by fiscal year--from 1965 through 1969. The function of this question was to determine the anticipated losses in the immediate future from all causes.

4. The number of journeymen by trade. Five of the assumed most populated trades were listed with space for additional write-ins. The purpose of this question was to determine those particular trades that, due to the number of journeymen involved, should receive primary attention in the development of formal training programs.

5. Each activity was asked if it had a certified apprentice program and if so, in what crafts and for what number of years. The purpose of this question was to determine

---

[6] Assumed to be the youngest age at which a man could qualify as a journeyman, considering most apprenticeship programs are of four years duration.

the correlation between active apprenticeship programs and size of acitivity; what correlation existed with questions 3 and 4 above; what correlation existed between activities with respect to the types of trades apprenticed and their duration.

6. Each activity was asked the same questions, for the same reasons as question 5 above with respect to having a skill updating program. In addition, each activity was asked if skill updating programs existed in their area; if so, the subject or skill and the duration of the course and by whom the course was operated. An additional purpose of this question was to determine if all activities in the same locality were equally aware of local existing training programs.

7. Each activity was requested to indicate its present method of recruiting journeymen, by rating the four methods known to the writers: (1) by graduation through an activity apprenticeship program; (2) by promotion of journeymen helpers; (3) by hiring certified journeymen from the labor market, and (4) by hiring men from the labor market with general experience but no formal training. The purpose of this question was to determine the availability of skilled craftsmen in the labor market[7] and secondly to determine the preference between promotion of helpers and hiring persons with general experience.

8. Each activity was requested to indicate what type of activity it was, i.e. shipyard, air station, etc. The

---

[7] It is assumed that a certified journeyman would always be hired before promoting helpers or hiring persons with only general experience.

purpose of this question was to determine if any correlation existed between the type of activity and the information provided through the above questions.

The letter of transmittal, (See Fig. 3, page11), explained the purpose of the study and requested the questionnaire be returned by 15 March, 1964.

It was decided not to request comments on the premise that those who were interested and had constructive information to offer would do so. They did.

III. INTERVIEWS

Arrangements were made to conduct interviews with several professionally "expert" persons involved in various aspects of the need for, testing, selection, initial training, and skill updating of skilled craftsmen--both in the Navy and private industry. Considerable information used in the development of this paper came from these individuals, either through oral interviews or literature they provided. Of particular value were interviews held with:

1. Mr. Gilbert O. Davidson, Apprenticeship Consultant, Department of Industrial Relations, State of California. Mr. Davidson, both during the interview and later by correspondence, was of enormous assistance in providing a variety of data with respect to the status of apprenticeship programs on the national and State of California levels in the construction and manufacturing industries.

2. Doctor Roy H. Hutchison, Director of Training, U. S. Naval Air Station, Alameda, California. Dr. Hutchison, in addition to providing much information on apprenticeship

U. S. NAVAL POSTGRADUATE SCHOOL
SMC #2710
Monterey, California 93940

14 February 1964

Dear Sir:

CDR. J. C. Day, Jr., CEC USN and Lt. T. L. Lonegan, CEC USN are presently conducting a research study in connection with the Management Department of the U. S. Naval Postgraduate School, and request your assistance. An attempt is being made to determine the need for developing apprenticeship programs that will train and educate Public Works journeymen to the levels that will be required in the coming years.

Your assistance in completing the enclosed questionnaire will be appreciated. Because of the restricted time schedule for evaluating this information it is requested that the questionnaire be returned by March 15.

Very respectfully,

J. C. DAY, JR.
Commander, U. S. Navy

Fig. 3 - Questionnaire Letter of Transmittal

training in the Navy, allowed the writers to use his personal library on the historical and economic aspects of apprenticeship training.

IV. REVIEW OF PERIODICALS

An exhaustive review was made in the U. S. Naval Postgraduate School Library, primarily in the field of current periodicals. The emphasis was on international, national and specific industrial trends in formal training. Also surveyed were testing procedures, interviewing, program formulation, and a number of special studies on new techniques currently being tested. A considerable number of pertinent articles and papers were ordered from the Bureau of Apprenticeship of the Department of Labor but, unfortunately, were not received prior to the sumbission of this paper.

V. CORRESPONDENCE

Based on data received and information learned from the initial investigation, returned questionnaires, interviews and the review of current periodicals, correspondence was conducted with a number of Naval activities which have active apprenticeship programs. Of particular value was information received from:

1. U. S. Naval Propellant Plant, Indian Head, Maryland
2. U. S. Naval Ordnance Test Station, China Lake, California
3. Marine Corps Supply Center, Barstow, California

SECTION III

THE NEED FOR PRODUCTIVITY

I. INSUFFICIENT MAINTENANCE FUNDS

Funds made available and used for facilities maintenance are not sufficient to support the level of maintenance necessary from the standpoint of sound engineering and business standards. For the past eight years the backlog of essential maintenance, (BEM), of U. S. Navy owned facilities, (Class 1 and Class II property),[8] has approximated one percent of the replacement value of such facilities. This is illustrated by Figures 4 and 5, (pp 14 and 15), which show that at the end of Fiscal Year, (FY), 1955 the Navy facilities had a replacement value of $13.13 billion and a BEM of $152.2 million. This had grown to $18.57 billion plant value and $180.4 million BEM by the end of FY 1961.

Looking into the immediate future, it is apparent that, unless some positive action not now programmed is taken, the backlog of essential maintenance will not be reduced, but may even increase above one percent.[9] These assumptions are borne out by Table I, (p. 16), which shows that the level of budget obligations and expenditures for the maintenance of the Navy facilities has remained relatively static in the range of $205/$212 million annually.

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[8] Class I property is land and Class II consists of buildings and structures.

[9] Department of the Navy, "Facilities Management Study," Review of Management of the Department of the Navy, Vol II, Study 6, (Washington: Government Printing Office, 1962), p. 38.

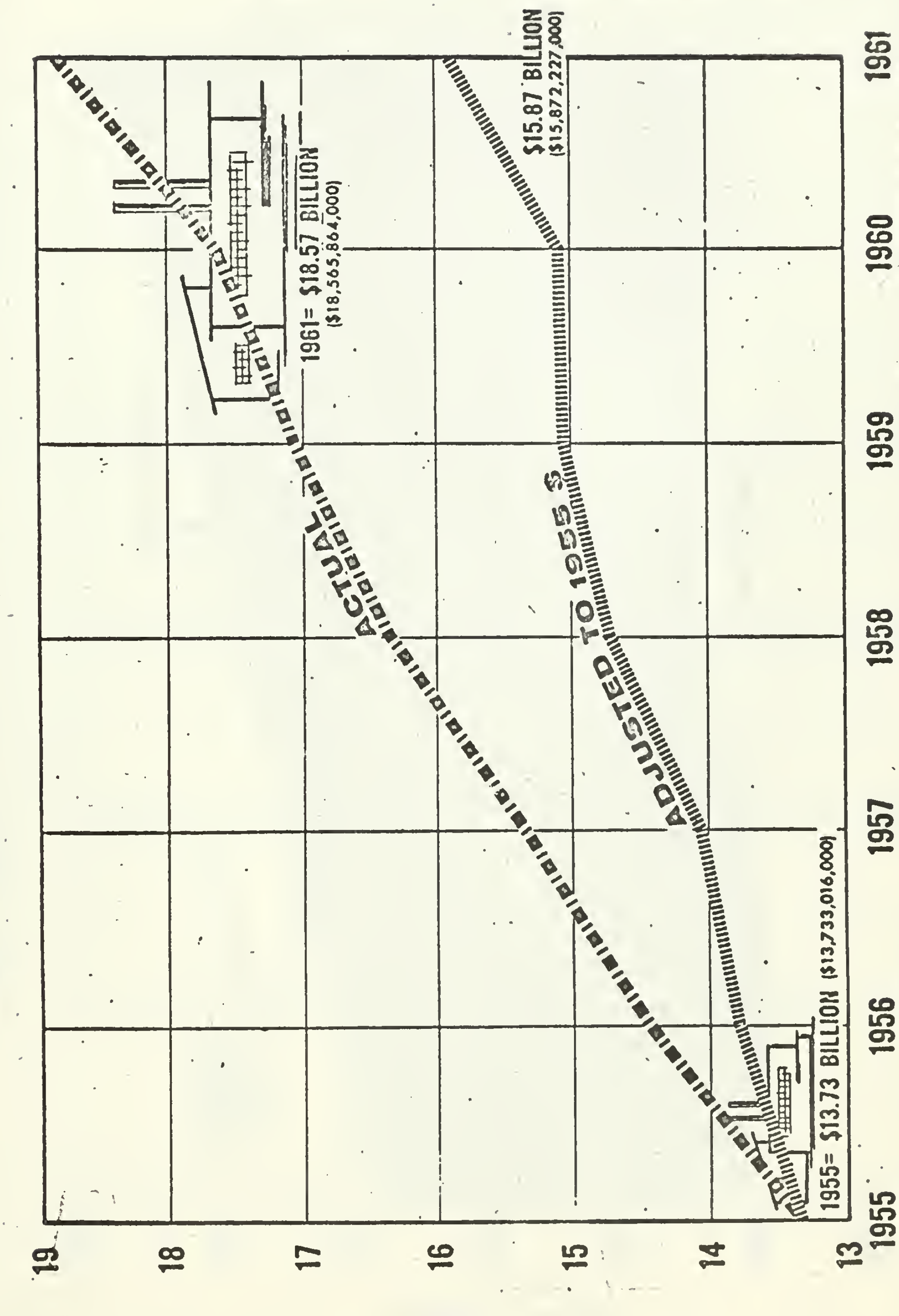

Fig 4. - Plant Replacement Cost In Billions of Dollars (Department of the Navy, Facilities Management Study, Vol. II, 26 October 1962, p. 97.)

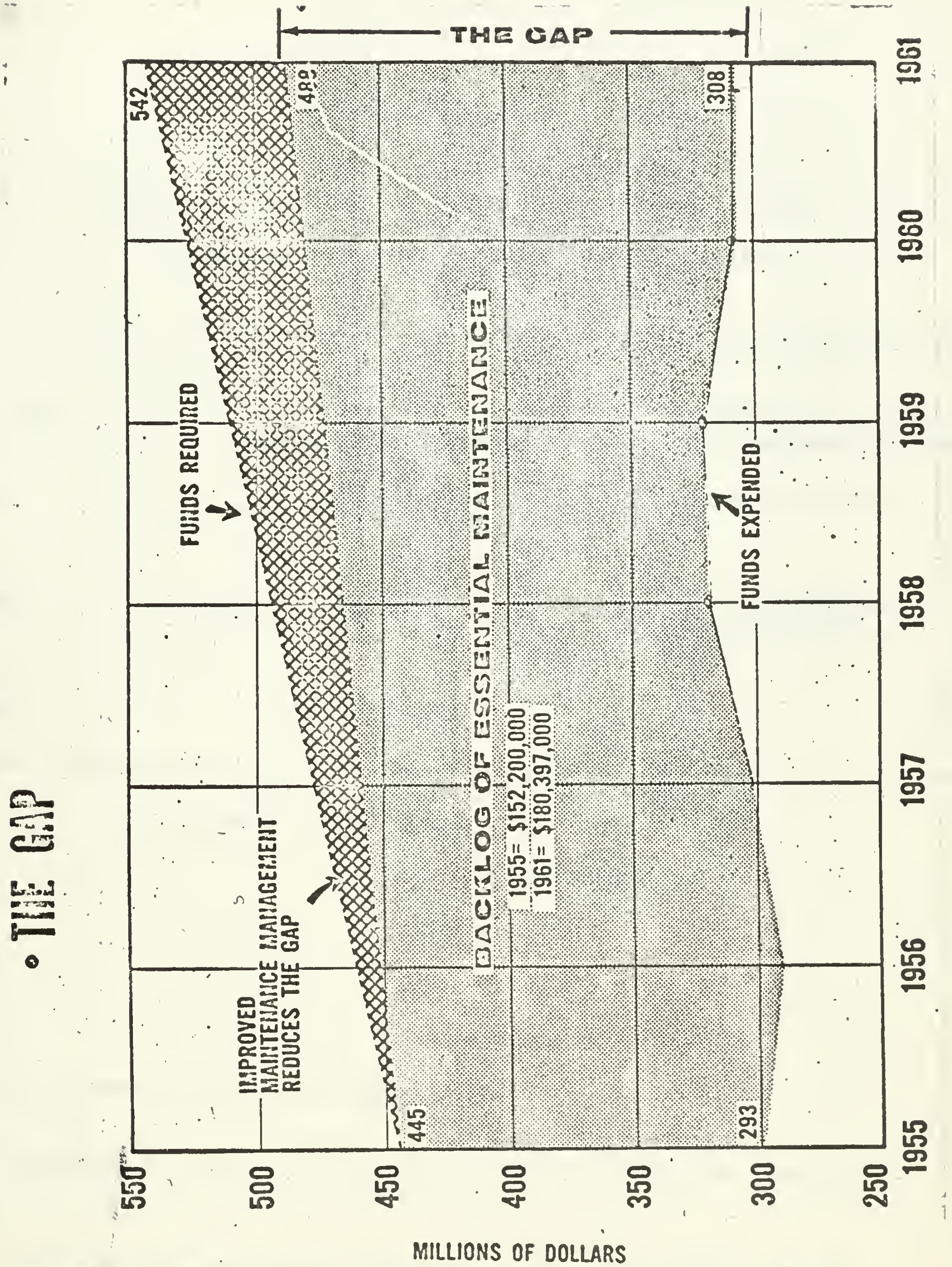

Fig. 5 - Backlog of Essential Maintenance

(Department of the Navy, Facilities Management Study, Vol. II 26 October 1962, p. 98.)

Table I - Comparison of Budget Obligation and Actual Expenditures For Maintenance of Real Property

FISCAL YEAR		BUDGET SOURCE: NCB 153 Summary	EXPENDITURE ACCOUNTS SOURCE: BuDocks BEAM Rpt.
1961		$208,022,000	$235,886,175
1962	Full Year	205,501,000	Projected 220,000,000 (6 months)109,885,084
1963		212,395,000	

All figures include O & M Navy
O & M Marine Corps
RDT&E
NIF
Maintenance, Real Property

Compiled by Bureau of Yards and Docks 5/16/62

Note: Expenditures are those incurred and entered during the fiscal year.

(Department of the Navy, Facilities Management Study, Vol. II, 26 October, 1962, p. 99.)

A portion of the increases in both the backlog of essential maintenance and in the replacement value of the facilities between 1955 and 1961 results from cost increases during this period. However, by adjusting the 1961 figure to 1955 dollars, a net increase of $2.14 billion in 1955 has occurred. (This included taking the plant acquisitions and disposals occuring during the period into consideration.) Thus, this $2.14 billion increase represents the physical expansion of the Navy's facilities and as such it has been a direct influence upon the over-all maintenance workload.

II. SIZE, AGE, AND COMPOSITION OF FACILITIES

The exact extent to which past deferrals of essential facility maintenance have had a deleterious effect upon the support of the Operating Forces or have resulted in abnormal future costs is impossible to determine because the Navy's system of records and reports does not lend itself to a definite appraisal of this area. Nevertheless, sufficient documentation exists in the form of Navy Inspector General, (NIG), reports to show that it has, in numerous instances, been a significant factor in morale, in limiting operational flexibility, and in generating abnormal future maintenance costs. These reports have included examples of barracks, BOQs, hospitals, runways, and aprons that have deteriorated beyond the point of economic repair. Additionally, the Navy's high BEM has been a concern to the Congress, as evidenced by the House of Representatives Report on the FY 1963 DOD Appropriation Bill.

The facilities of the Navy are undergoing constant evaluation that is tending to increase both the magnitude and the relative urgency of the maintenance function. As the existing plant increases in age, additional maintenance workload can be expected. With respect to the new facilities entering the plant account through the Military Construction Program-Navy, (MCON), the complexity of the plant is increasing due to changes in naval weapons systems which have increased the requirement for environmental controls such as heating, cooling, and ventilating. The increase in this type of control, with its inherent complexity and more narrow limits within which these sophisticated equipments must be operated, further increases the maintenance workload as well as limiting the ability to defer essential maintenance without incurring immediate drastic results.[10]

III. BACKLOG OF ESSENTIAL MAINTENANCE

The term "backlog of essential maintenance" is defined in NAVDOCKS P-322, Vol. 1 as follows: "The backlog of Essential Maintenance and Repair of Public Works and Public Utilities such as buildings, structures, pavements, utility systems, grounds, etc., which should be corrected to conform to maintenance standard as contained in NAVDOCKS P-322. The deficiencies should be of such urgency that they should be funded approximately 12 months following the reporting date."

The BEM is made up of several thousand individual

---

[10] Department of the Navy, Op. cit., pp. 39-40.

projects, each of which has been developed on a sound engineering basis under the supervision of a qualified Public Works Officer, usually a Navy Civil Engineer Corps Officer. At any one time, this backlog to some extent represents projects which are in the process of being funded and scheduled for accomplishment. However, the great bulk of the backlog is maintenance work that, although meeting the criteria of the above definition, has had to be deferred because of an over-all insufficiency of funds alloted for real property maintenance. It is the magnitude and the continuing nature of this latter portion of the backlog that presents a serious problem in maintaining the Navy's facilities at the level which, from the standpoint of sound engineering and business standards (developed and generally accepted by industry), is considered most economical. BUDOCKS has sponsored maintenance management workshops and has had direct contact with major industrial corporations owning facilities comparable to the various types of Navy facilities. Contacts with major industrial corporations have been accomplished through participation in maintenance management courses given by the American Management Association. As a result of these proceedings, BUDOCKS has arrived at the professional opinion that, in order to overcome accelerated deterioration induced by the non-performance or overlong deferral of essential maintenance work, it would be in the best over-all economic interest of the Department of the Navy to reduce the present BEM to a level of 0.25% of the replacement

value of the Navy-owned facilities as illustrated by Figure 6, (p. 21), and to endeavor to hold the BEM within this limit.[11]

IV. FACILITIES MAINTENANCE MANAGEMENT

During the past ten years, the Navy has developed a facilities maintenance management program that has proven itself to be highly effective in many respects in partially solving the afore mentioned problems.

In October 1954, the Secretary of Defense, (SECDEF) issued policies and objectives governing maintenance of real property and operations of utilities, which were immediately implemented by the Secretary of the Navy, (SEC NAV), with SEC NAV Instruction 11011.5 of 21 October, 1954, Subj: Objectives and Policies Relating to the Real Property Maintenance and Utilities Operation Program. This instruction required that supervisory improvement programs aimed at improved management and supervision of maintenance and utilities operations would be initiated and/or continued. This instruction provides the character for establishment of the controlled maintenance program in the Department of the Navy.

In order to amplify the policies and objectives set forth in his October 1954 directive, SEC DEF issued DOD Directive 4165.9 of 23 June 1955, which was promulgated by SEC NAV Instruction 11014.3 of 29 June 1955, Subj: Programs for Management of Real Property Maintenance Activities. This program contained provisions for operational guides and for

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[11] Department of the Navy, Op. cit., p. 40.

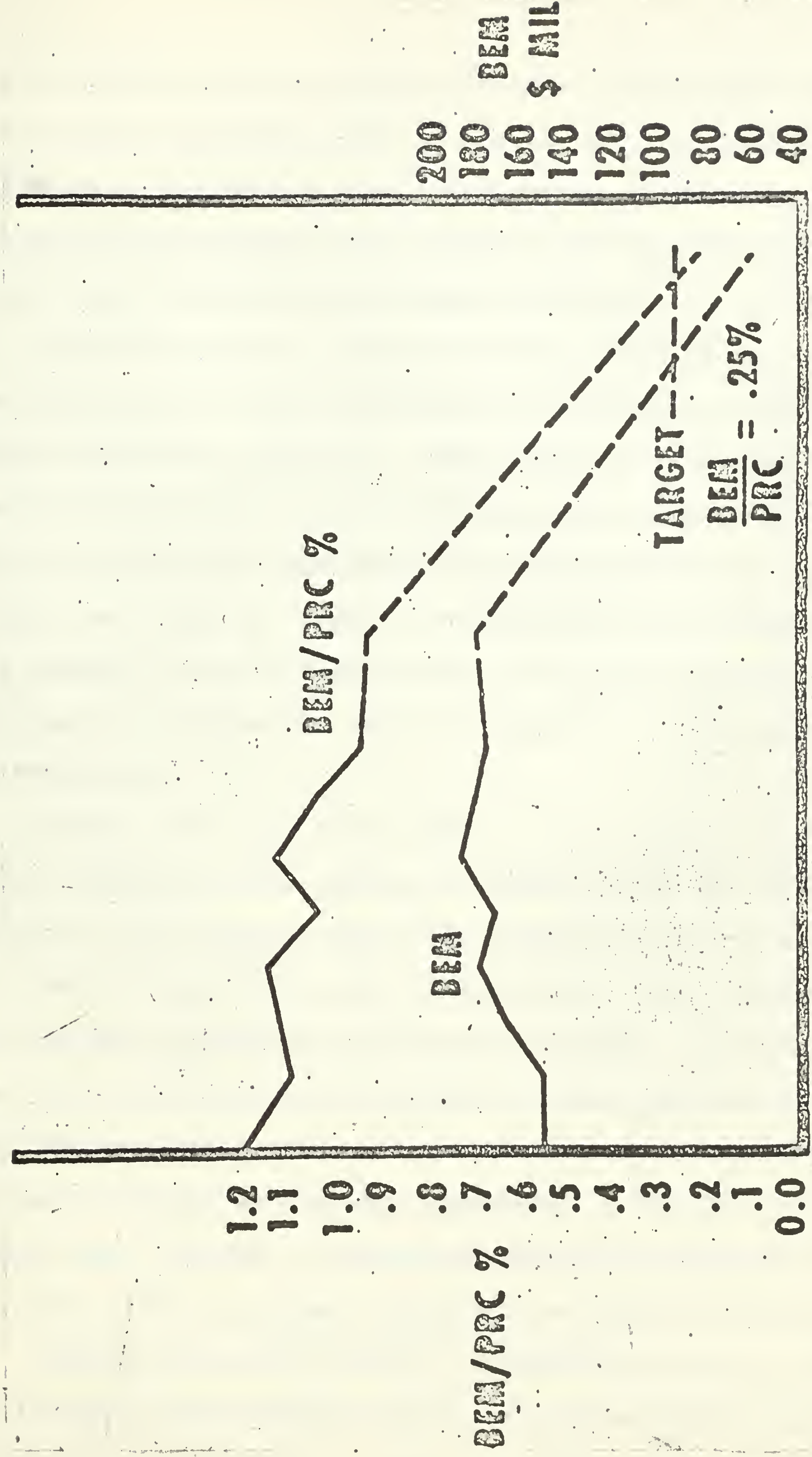

Fig. 6 - Backlog of Essential Maintenance As A Percent of Replacement Costs

cost classifications, property records, performance and maintenance standards, maintenance force size, planning and estimating, inspection, job order system, scheduling backlog of work and evaluation and reporting, which would form the basis for a controlled maintenance program.

BUDOCKS prepared, and in November 1956 issued, TP-PW-33 now redesignated P-321--Maintenance Management of Public Works and Public Utilities. This document contained a controlled maintenance program for implementation by field activities which was responsible to SEC NAV direction. This action was taken by BUDOCKS in accordance with responsibility assigned by Navy Regulations, to provide technical direction for the Navy in matters relating to maintenance of real property.

In SEC NAV Instruction 11014.7 of 21 February 1958, Subj: Maintenance Management of Public Works and Public Utilities, SEC NAV expressed his concern over ever-increasing cost of the maintenance of the Navy's shore facilities and the non-availability of required funds. He stressed the fact that the only means available at that time to close the gap between fund requirement and fund availability was through improved maintenance management. SEC NAV advised bureaus and offices to accelerate adoption of procedures for the controlled maintenance programs set forth in TP-PW-33.

BUDOCKS reissued TP-PW-33 as NAVDOCKS P-321 in 1959. This reissue incorporated revisions and contained changes which were evolutionary. Since inception, the controlled maintenance program had been studied and evaluated, including civilian consultant evaluation, in an attempt to

BUDOCKS.

Though initially somewhat restricted, under the added stimulus of SEC NAV, the scope of the seven Public Works Centers has been increased by directing that activities within given areas would obtain all of their public works support from the Public Works Centers.

At the present, there are twenty seven (27) recognized Navy complexes of geographically clustered activities throughout the world.[14] For example, there are now 72 separate activities in the Norfolk complex alone.[15] The quantity of facilities and maintenance personnel necessary to maintain them is numerous-approximately 40,000 public works personnel. Public Works Centers at Seven of these complexes employ approximately 16,500 personnel. It is expected that Public Works Centers will be established at, at least, three other complexes in the future, employing an additional 4000 public works employees.[16] This will result in at least ten major public works activities with an average personnel allowance of over 2000. The vast majority of these personnel are or should be, skilled craftsmen.

VI. CURRENT LEVEL OF PRODUCTIVITY

During the period 1955 to 1961, the Navy has through

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[14] See Table II, p. 27.

[15] Department of the Navy, Op. cit., p. 6

[16] Bureau of Yards and Docks Representative, loc. cit.

1. Boston, Massachusetts
2. Newport, Rhode Island * 1958
3. Portsmouth, New Hampshire
4. New London, Connecticut
5. New York, New York
6. Philadelphia, Pennsylvania
7. Norfolk, Virginia * 1948
8. Charleston, South Carolina
9. Key West, Florida
10. Jacksonville, Florida
11. New Orleans, Louisiana
12. Great Lakes, Illinois
13. Guantanamo Bay, Cuba * 1956
14. San Diego, California * 1963
15. San Francisco, California
16. Los Angeles, California
17. Seattle, Washington
18. Bremerton, Washington
19. Pearl Harbor, Hawaii * 1954
20. Washington, D.C. (exclusive of the Navy Department)
21. Annapolis, Maryland
22. Rota, Spain
23. Naples, Italy
24. Yokosuka, Japan * 1963
25. Okinawa
26. Guam, M.I. * 1949
27. Subic Bay, Philippines * 1955

* Year a Public Works Center was established

Table II - List of Naval Complexes - World Wide

improved public works management and advancements in technology, steadily increased the productivity per man-hour of the labor force employed in public works functions.

During 1955, the last year before beginning the controlled maintenance program, the Navy was able to maintain $46.90 of plant account (replacement cost) for each maintenance dollar expended. Reports for 1961 indicate that $60.36 of plant account was maintained for each maintenance dollar spent.[17] During this time, BEM has been relatively static at one percent of plant replacement value expressed either as current dollars or in terms of 1955 dollars. This improvement in effectiveness has been achieved (1) by improving maintenance standards which establish a level of required maintenance consistant with the relation of particular facilities to the military mission of the activity and the Navy, and (2) by increasing productive effort. As shown on Figure 8, (page 30), from 1955 through 1961 the control of productive man-hours has been increased from forty seven to seventy seven percent.

In the same period, the amount of manpower devoted to alterations and improvement type work has decreased from nine to six percent, and the amount of effort on emergency type work has remained relatively constant at about two percent. There are practical limitations on how far these controls can increase or decrease the effort, since some alterations and improvement is necessary to meet changing conditions,

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[17] See Fig. 7, p. 29.

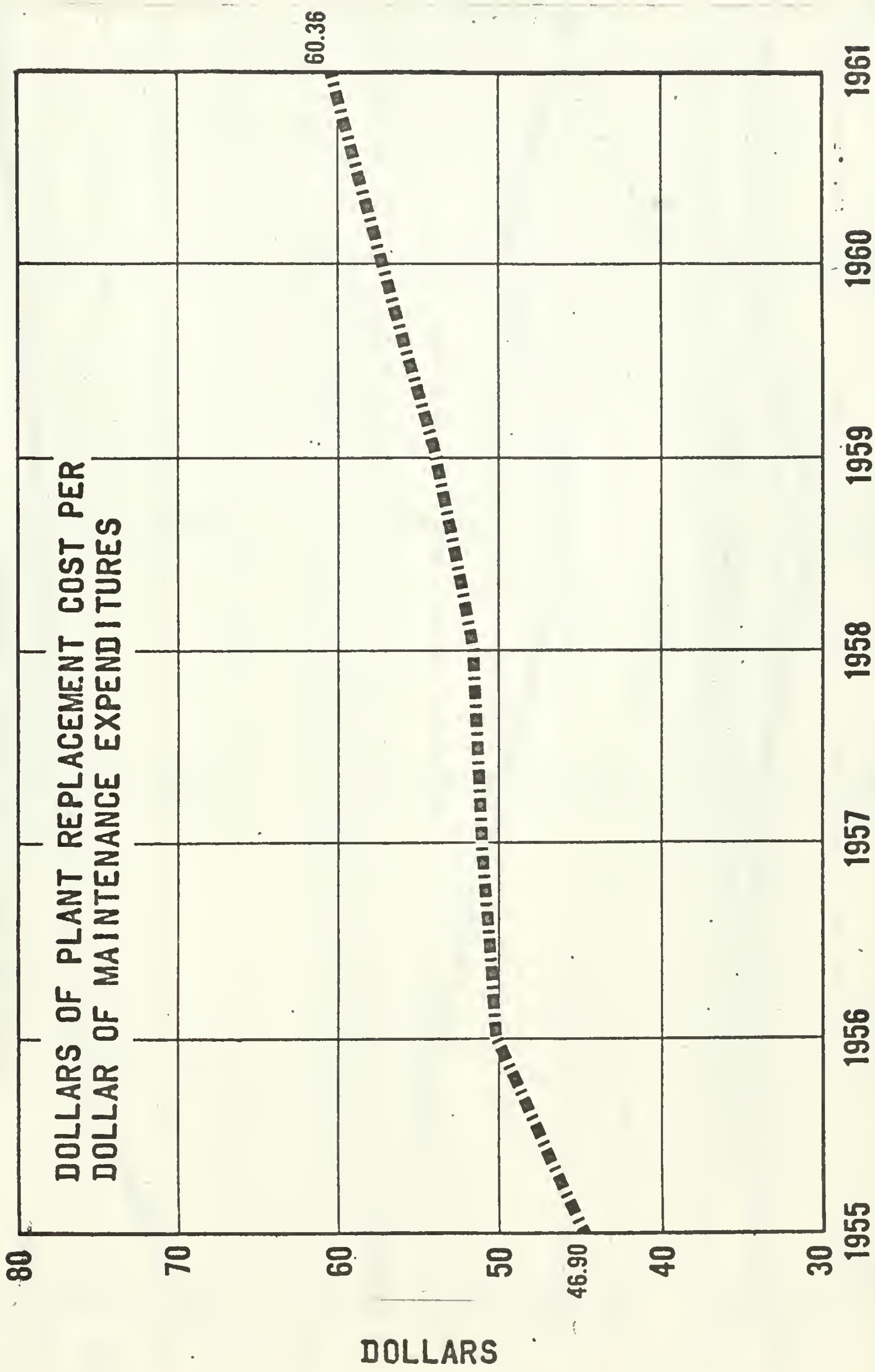

Fig. 7

(Department of the Navy, Facilities Management Study, Vol. II, 26 October 1962, p. 100.)

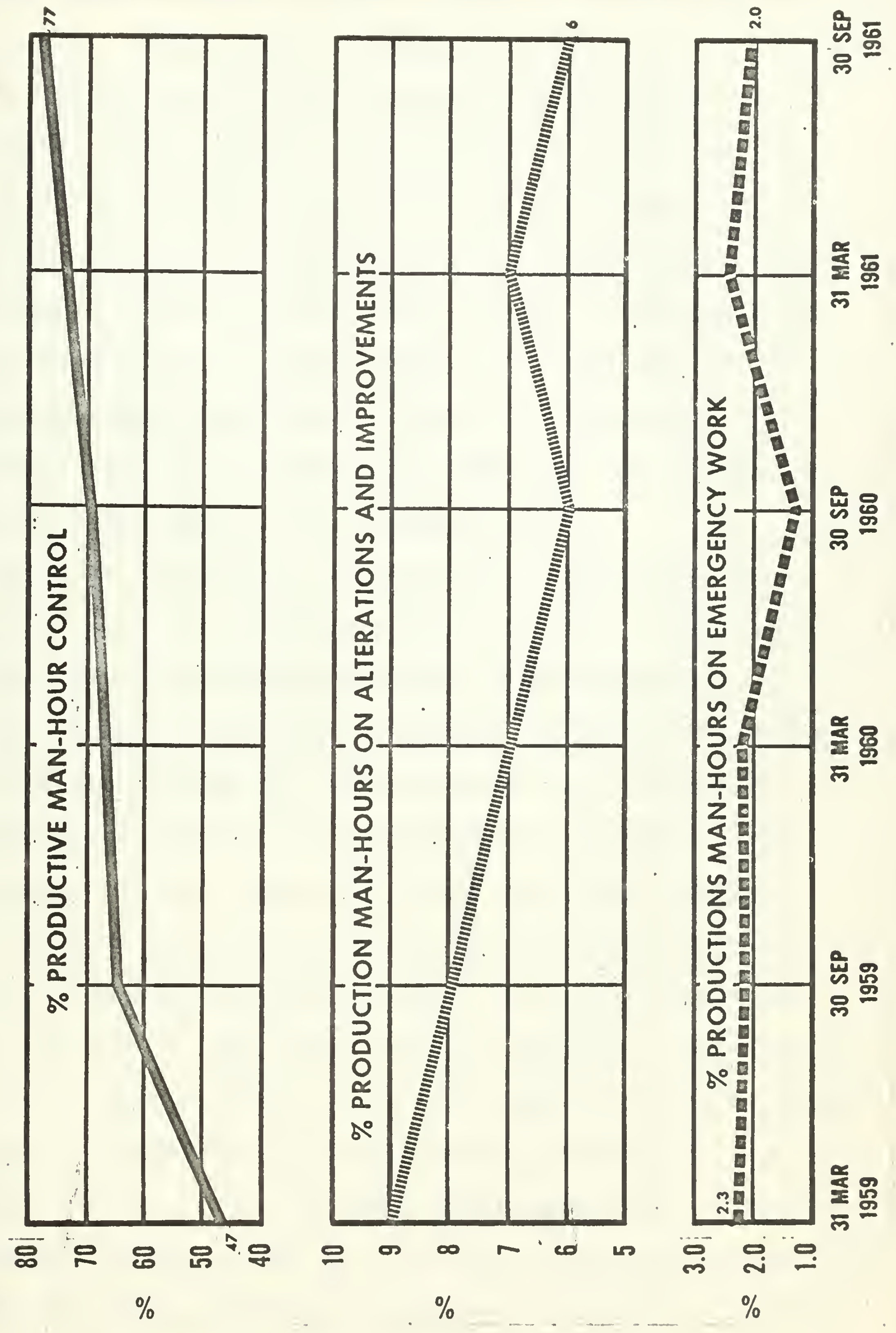

Fig. 8 - Increase in Productivity 1959 - 1961

(Department of the Navy, Facilities Management Study, Vol II, 26 October, 1962, p. 101.)

[illegible]

and since some emergency work is desirable to avoid overmaintenance. Thus, while it is anticipated that the upward trend in public works effectiveness will be maintained, it is probable that, as over the past years, it will not be sufficient to do much more than offset the rising cost of the labor and materials employed in the maintenance effort. Accordingly, although every effort should be continued to exploit to the fullest improvements in management and in technology, such improvements cannot by themselves be relied upon to solve the problem of reducing the backlog of essential maintenance to the desired level.

The area that has in the past and continues in the present to hold the greatest promise is that of increasing the relative effectiveness in terms of productivity. As has been shown, a substantial increase in productivity has been possible through (1) the evolution of a facilities management program and (2) consolidation of public works activities. It has also been stated that these programs have practical limitations with respect to any future substantial increases in productivity. It is the contention of the writers of this paper that the relative effectiveness in terms of productivity of the labor and materials utilized in facility maintenance is also directly related to the degree and quality of the training given personnel. Therefore, the purpose of this paper is to survey the present status and analyze the future need for formalized training of facility maintenance personnel in public works activities.

SECTION IV

HISTORY OF APPRENTICESHIP

Apprenticeship has been traced from ancient times through the present day. Summaries of apprenticeship programs from antiquity through the Medieval, the Elizabethan, and Early English Periods; the Colonial American Period; the Industrial Revolution and the period up to the passage of the National Apprenticeship Act in 1937 are a few of the historical highlights to be discussed in this section.

Since this study pertains to the need for training and increased productivity today, particular attention has been given to the general conditions in the past under which periodic need for better training has revealed itself.

This section was written in an attempt to include information that would present an integrated and total picture of apprenticeship.

I. ANTIQUITY

It appears that apprenticeship has existed from the earliest periods of recorded history. According to Bergevin[18] the Code of Hammurabi, (circa 2100 B.C.), which is the "oldest surviving code of laws", must have been written because of conditions prevalent at that time. Laws and regulations established by custom inspired attempts to codify procedures, abolish political inequalities, and to set aright the business of apprenticeship. Bergevin

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[18] Paul Bergevin, Industrial Apprenticeship, (New York and London, McGraw-Hill Company, 1947.)

has pointed out that:

> Apprenticeship reached a state of development in Egypt during the first century B.C., comparable to apprenticeship in medieval Europe. Indentures have been found in ancient Egyptian tombs, specifically outlining the relationship of apprentice and master, indicating the trade to be taught and the required period for apprenticeship.[19]

Although written records are not continuous throughout history, other existing evidence in the crafts make it reasonably certain that apprenticeship has had an uninterrupted history from the beginning of civilization. With primitive man, apprenticeship probably began as an unconscious process of imitative learning and later became incidental to learning and teaching for ordinary primitive daily existance. In early historical ages it merged into the process of craftsmen adopting sons, and later appeared as a recognized contractural relationship between craftsman and parent or master and learner.

A father usually taught his son his own occupation. This father-son relationship was a characteristic of apprenticeship throughout history until the rise of state apprenticeship in the sixteenth century. Sons were even adopted by artisans as evidenced in the Code of Hammurabi, which stated that "if an artisan has taken a son to bring up and has caused him to learn his handicraft, that nursling shall

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[19] Ibid

not return to his father's house."[20] This was an accepted institution of apprenticeship in which, through the forms of adoption, a boy was indentured for life.

Babylonian and Assyrian history show apprenticing of slaves to have been common practice and there are examples of slaves who had been taught a handicraft and who were also skilled artisans. Frequently the person to whom the slave was apprenticed, was a slave himself.

In ancient Egypt no fixed period of apprenticeship was required. The terms of months or years was a matter of contract and the term differed in the same crafts. The master paid for the food and clothing of the apprentices, and wages varied according to the skill of the learners. Masters agreed to teach the apprentice the trade in return for their labor. Most contracts contained clauses on food, clothes, lodging, wages, the term of service, fines for breach of contract, taxes of apprentices, obedience to masters, lost time, obligation of the master to teach, and the observance of holidays.[21] The age at which a boy entered a contract varied considerably since there was no formal control of apprenticeship.

Apprenticeships were present during the Roman Empire. According to contracts in this era, the artisan gave trade

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[20] Arthur B. Mays, Essentials of Industrial Education. (New York: McGraw-Hill Book Co., Inc. 1952), pp. 241.

[21] Paul Monroe, A Textbook in the History of Education. (New York: The MacMillan Company, 1949), pp. 253-255.

instruction, plus other considerations, to the apprentice in turn for labor. There was no definite term of service or rate of wage; these matters again were done by contract. In Athens, scholars accepted apprenticeship as an essential factor in the economic life.

During the Dark Ages and Renaissance the monasteries played an active role in training and education. In order to live a religious life, the monks had to learn to read the Scriptures and also to copy manuscripts. Also, it was necessary for them to learn manual skills and crafts to maintain themselves.

In ancient times, apprenticeships were used not only to prepare men for handicrafts, but for all forms of industrial and professional work. Entrance into all professions was achieved through apprenticeship. Lawyers were trained by practicing attorneys in law offices, dentists and doctors were educated in a similar manner.

II. MEDIEVAL AND EARLY ENGLISH PERIODS

In the eleventh century craft guilds appeared and, since indentured apprenticeship was a characteristic feature of the later craft guilds, it is assumed that it existed in some form among the early guilds. The craft guilds appeared slowly and did not become powerful in city affairs until the fourteenth and fifteenth centuries, when they seem to have superseded in importance the older merchant guilds.

As early as 1261 there are references in London regarding apprentices and apprenticeship fixing terms of service

at ten years.

The apprentice had to serve faithfully, work diligently, and make himself useful. The master obligated himself to teach the apprentice all phases of the trade, and to give him all the care due to his own son--shelter, food, clothing, and moral and religious instruction. No references were made to wages, only entrance and completion dates. Apprenticeship was expected to provide not only a good craftsman but also a good citizen.

The Medieval apprenticeship stressed personal family relationship and its success as industrial education seems to be due chiefly to this feature. Again, the worker lived his education and, for seven years, education was his life, full time education in every sense of the word. The young learner was bound out by his parents to a master craftsman and for periods up to seven years, he worked and lived with his employer.

After the enactment of the Statute of Artificers, in 1562, seven years was uniformly required as the term of indentures in England. It was also known as the Statue of Labourers and Apprentices and under it all people who exercised trades were required by law to have spent seven years, at least, as apprentices in their particular trade. There were several other important points in this Statute:

(1) The apprentice was bound by a formal written indenture. His term was fixed at seven years unless he was under seventeen years of age. If he was seventeen or older,

his apprenticeship term did not expire until he was twenty four years of age. This protected existing craftsmen from an over-supply of skilled workers in their field; provided a supply of cheap labor; and assumed complete mastery of the trade necessary before the learner would be classified as a master.

(2) Only responsible householders were permitted to take apprentices. Agreements were made only with masters who owned their own homes and businesses.

(3) Only townspeople could enter apprenticeships; country people were excluded. This favored the town boys and gave them an opportunity for a trade more profitable than agriculture.[22]

Apprenticeship was important as an effective restraining and social agency when the social and political life was not well organized. It was effective for training skilled craftsmen, and protected the guilds against the new domestic system of production. Apprenticeship, however, outlived the guilds and co-existed in the development of the factory system of production. Apprenticeship, reached a high degree of complexity and importance and became an institution of the state in the sixteenth century England and in the seventeenth century colonial North America. It passed through periods of neglect but played a major role in industrial education and is today important in training for industry.

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[22] Arthur B. Mays, The Century Education Series: The Problem of Industrial Education, (New York: The Century Co., 1952), p. 299.

Even with restrictions such as high fees for freedom and rules to protect the prestige of the guild, the new domestic system of production soon all but eliminated the craft guilds.

Under the state direction the old personal relationship soon degenerated into that of employer and worker, and later to that of exploiter of the workers, both child and youth. The element of supervision almost wholly disappeared. Queen Elizabeth's famous Statute of Artificers (1562), which sought to enforce uniform restrictions on the practice of a trade in England, failed to realize its intended purposes. The Poor Law, subsequently passed, forced pauper children into apprenticeship and made available an enormous supply of cheap, unprotected child labor. Not many years after state apprenticeship and state compulsary labor for paupers supplanted guild apprenticeship, one of the worst forms of Child labor the world has ever known developed in England and later appeared in America. Industrial organization led to an ever increasing division of labor and finally, together with other economic disturbances, such as the fall of the value of money, the number of enclosures on farm lands and cheap labor, helped to make the growth of the domestic system of production easy and the enforcement of guild apprenticeship increasingly difficult. The guilds slowly receded into the background and eventually, with the establishment of colonies in distants lands, a new economic system came about and the guilds disappeared.

III. COLONIAL AMERICAN PERIOD

The essential characteristics of the practice of apprenticeship in the American colonies were determined by English guild and municipal legislation of the thirteenth and fourteenth centuries.

Apprenticeship soon modified its character and became a means of common education as well as a method of training mechanics and a type of poor relief. The system was a complicated one, sometimes being used as a form of punishment for debt, the indenture being made out for apprenticeship instead of for servitude. As a result, indentured servants received the benefit of trade training and at other times apprentices were treated like servants.

In the colonies, most of the apprenticeship existed in the North since this section had early developed into the industrial part of the country. The indentured servant was employed in greater numbers in the South. Two classes of apprentices existed, those that were voluntary and those that were forced. The later consisted of orphans, paupers, incorrigibles, etc. Usually, the term of apprenticeship was seven years; however, there were some exceptions. It seems that there was the feeling that shorter apprenticeship might be detrimental to the crafts.

The master provided the board, lodging, and clothing and was responsible for giving the apprentice trade and general information. Frequently, the apprentice was taught how to read and write and was given some religious instruction.[23]

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[23] Paul Bergevin, Industrial Apprenticeship, (New York: McGraw-Hill Book, Inc., 1947), p. 13.

Colonial and town governments assumed general supervision of the relationship of master and apprentice. This in turn brought about other laws to protect both apprentices and masters. From all this came what might be termed "state" supervised systems.

Labor needs in the factories of the colonies and an over supply of labor in England encouraged emigration to the colonies. The problem of transportation for the poor was solved with indentured servitude or apprenticeship without its educational opportunities. The servant guaranteed to work for a specific period of years for his transportation. In this situation, there were two classes of indentured servants:

(1) those who sold themselves in return for their passage or to the highest bidder upon arrival; and (2) the "free-willers" who did not sell themselves to the ship-master but engaged passage and then sold themselves into servitude upon arrival in the colonies. Most of the indentured servants taken out of England were for servitude but many were for apprenticeship. A person falling into debt could be siezed and sold into service if he were not able to pay the debts after he arrived in the colonies. All the indentured received from his master when freed was some clothing, a few bushels of corn, and a tool or two--sometimes a gun.

The coming of the factory system in the nineteenth century stemmed from the opening of Slater's (textile) mill in New England. The fact that the beginning of the factory system coincided with the laissez-faire theory of economics

served to hasten the growth of child labor and the destruction of a genuine apprenticeship. Near the end of the colonial period apprenticeship declined rapidly in importance. Regulations were relaxes with reference to the term of apprenticeship and the standards of training. It became little more than a form of cheap labor. The decline in effectiveness and popularity was due mainly to; (1) the early mills in which the trades were increasingly broken up into specialized processes that could be learned in a short time; (2) social prejudices against manufacturing occupations because of their almost invariable association with poverty and pauperism; (3) the ease with which land could be obtained and one could become an independent farmer and landowner; and (4) increasing importation of foreigners from Continental Europe who were trained in the trades.[24]

Child labor was substituted for trained workers. The economic doctrine of laissez-faire was accepted by employers. Labor organizations were weak and machines were substituted for skilled workers in the factories. The old apprenticeship had almost disappeared by 1860. Genuine apprenticeship was greatly retarded by the mistakes of labor and industry and so likewise retarded has been the solution to the problem of industrial education in the United States.

IV. FROM THE INDUSTRIAL REVOLUTION

The advent of the American Industrial Revolution has

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[24] Arthur B, Mays. The Essentials Of Industrial Education (New York: McGraw-Hill Co., Inc., 1952), p. 46.

no fixed date because of the slow transition up to the factory system. Progress varied both by industry and locale. The South remained for the most part on a handicraft basis long after the Civil War. On the "frontier", industries developed even more slowly. In the North, the factory system gained steadily during the twenties and made progress in parts of New England from 1840 to 1860. However, it was after the Civil War before its period of greatest growth began.

The power driven machinery that replaced hand tools affected the apprentice because it revolutionized his methods of work and his social status. The master's house had been his home and he worked closely with the master for which he received his board and clothing in return for his services. Industry made it impossible for the master to house all of his apprentices and so cash had to be paid in order for the apprentices to seek their own room and board. A wage earning apprentice appeared who had greater freedom, greater opportunity, but also greater possibilities of losing everything very quickly.

It was the control of apprenticeship that was one of the main reasons for the organization of some of the early unions such as the Green Glass Blowers in 1857, (and their reorganization in 1866), the German-American Typographical Union, the Brotherhood of Carpenters and Joiners, the Painters and Decorators Union, and the Union of Shoemakers known as the Knights of St. Crispin.

The question of apprenticeship became more serious with the Civil War. Military life withdrew so many men from

industry that a free use of apprentice labor seemed absolutely necessary. The expansion of the factory system after the Civil War brought increased division of labor and specialization of tasks. All around apprenticeship became still less common. Boys were not taught trades as a whole. The unions sought to regulate apprenticeship both by legislative enactment and by trade unions. The labor movement of the 1860's tried to effect the full rebuilding of apprenticeship.

Contemporaneous with the attempt to regulate apprenticeship by legislation went the attempt to regulate it by trade-union enactment and collective bargaining. At first the formulation of the rules governing apprenticeship was left largely to the local unions. This, of course, proved inadequate. A national problem could not be regulated by the uncoordinated rules of local bodies. Impotent as the local unions proved to be, the national bodies were just as slow in shouldering the responsibility for regulation.

The close of the Civil War found labor seeking legislation on apprenticeship standards. Companies once again attemped to enforce apprenticeship. Even with its many shortcomings and labor opposition, this was, at the time, a good system of general training because apprenticeship contributed annually to the wealth of the nation a large number of skilled workmen and molded the character of vast numbers who also had the ability to keep themselves gainfully employed.

Apprenticeship decreased around 1900 for economic and technological reasons as well as because of trade union regulations. However, the term "apprentice" had become so

loosely used that determination of actual bonafide apprentices was impossible to ascertain. Systems to train high-grade mechanics continued in many of the new industrial plants but became more specialized.

Bergevin mentioned that Massachusetts, Illinois and New York were leaders in state legislation on industrial education.[25]

The industrial education law, passed by the State of Wisconsin in 1911, marked the beginning of state regulation of apprenticeship by prescribing that every apprentice should receive not less than five hours a week of instruction in English, citizenship, business practice, hygiene, physiology, the use of safety devices, and such other branches as might be approved by the state board of industrial education. This law also provided for registration of all apprenticeship indentures.

In 1915 this apprenticeship law was amended to provide for: (1) compulsory indenture, (2) time for instruction in the continuation school; a minimum of five hours per week to be devoted to instruction and the employers were required to pay the apprentice for this time, (3) regulation of hours and wages; apprentices over 18 years could work overtime not to exceed 30 hours a month and were to receive for this one and one-half ordinary wage rates. (4) specification of the particular process to be taught the apprentice and approximate time to be spent on each, (5) supervision and direction of the system by the state industrial commission. This measure helped both in standardizing conditions and in offering

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[25] Bergevin, Op. cit., pp. 38-40.

an incentive for the apprentice to do their best and to complete their apprenticeship.

Despite the passage of legislation designed to benefit apprenticeship, the percentage of apprentices in the total work force in the United States continued to decline.

The crash of the stock market in 1929 and the "great depression" which followed all but "dealt the death blow" to apprenticeship. With millions of trained artisans unemployed (or employed only part time) there was little incentive or opportunity to train additional workers.

However, by 1937 the scarcity of skilled labor was acute in many trades. In the meantime local and national employers, labor organizations, educators and government officials--federal, state, and local-were expressing grave concern over the future of apprenticeship. Through the combined efforts of these various interests the federal government for the first time formally participated in promoting apprenticeship and the national apprenticeship law was passed by Congress. The law, popularly known as the Fitzgerald Act, was enacted to promote the furtherance of labor standards of apprenticeship; to extend the application of such standards by encouraging the inclusion thereof in contracts of apprenticeship; to bring together employers and labor for the formulation of programs of apprenticeship and to cooperate with State agencies in the formulation of standards of apprenticeship. It was an enabling act in every sense of the word, without mandatory injunctions.

As a result of this act,[26] the Federal Committee on Apprenticeship was reorganized and enlarged to include an equal number of representives of employers and labor, in addition to a representative of the U. S. Department of Labor and the U. S. Office of Education. Also Apprentice-Training Service (now known as the Bureau of Apprenticeship) was established as the national administrative agency in the Labor Department to carry out the objectives of the law in conformance with the policies determined by the Federal Committee. Since 1937 the Bureau of Apprenticeship has cooperated closely with employer, labor vocational schools, and others concerned in setting up and conducting apprenticeship programs throughout American industry.[27]

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[26] The Federal Committee on Apprenticeship was first created by the Secretary of Labor in 1934 to serve as the national policy recommending body on apprentice training in the United States. This committee was principally created to assume the responsibilities with respect to apprentices and their training under industrial codes formulated by the National Recovery Administration.

[27] United States Department of Labor, Apprenticeship Training, Past and Present, (Washington: Government Printing Office, 1952), p. 21.

SECTION IV

CRAFTSMANSHIP TRAINING IN THE NAVY TODAY

As a modern apprenticeship system emerged from the haphazard learning periods of the past, there developed two related patterns of training in industrial apprenticeship:

(1) The self contained company apprenticeship school;

(2) The joint program of apprentice training conducted by company and by public schools.

Both of these modern systems are used in the Naval shore establishment, as well as combinations of the two. In common with these two programs, the Navy does all of the shop training. In states where school regulations and school funds permit, the related instruction is frequently furnished by the local school departments, either in Navy or public school classrooms.

The following is a summation of the official policy involved in the establishment of an apprenticeship program at an activity in the Navy as directed by (1) Navy Civilian Personnel Instruction, Section 410 and (2) the Federal Personnel Manual, Section 337 - 3, 4, and 5.

I. OBJECTIVES

The Department of the Navy conducts apprentice training for the purpose of developing highly skilled, Navy-oriented journeymen thoroughly and broadly qualified in their trades, and to provide a potential source of key employees and supervisors. The Navy's apprentice training

program is designed to develop the character, personality, industry, and initiative of the apprentice, in addition to providing him with the technical skills and knowledges required in his chosen trade.

II. BASIC CONSIDERATIONS

Apprentice training is by its nature a long range operation. It is not designed to solve immediate emergencies, and it should be insulated from transitory retrenchments that disturb the programs stability. These are the factors to be considered in planning the establishment of an apprentice training program:

(1) The number of journeymen employed in each of the trades being considered for apprenticeship;

(2) The long range estimated requirements for personnel in these trades;

(3) The local labor market conditions and trends, including the extent of availability of adequately trained journeymen on a continuing basis;

(4) The availability of training staff assistance, and qualified shop and related information instructors;

(5) The adequacy of training facilities;

(6) The scope and complexity of the workload available at the activity to assure that apprenticeses will obtain well-rounded training.

Table III, page 49 shows a list of Naval activities authorized to conduct apprentice training and the trades authorized apprenticeable at each. Naval activities

APPRENTICEABLE TRADES / ACTIVITIES	BUREAU OF SHIPS															BUREAU OF NAVAL WEAPONS																				BUDOCKS					CNO	M.C.	ONR	S&A					
	DTMB, CARDEROCK	NRF, SAN DIEGO	NSY, BOSTON	NSY, CHARLESTON	NSY, LONG BEACH	NSY, MARE ISLAND	NSY, NEW YORK	NSY, NORFOLK	NSY, PEARL HARBOR	NSY, PHILADELPHIA	NSY, PORTSMOUTH	NSY, PUGET SOUND	NSY, SAN FRANCISCO	SRF, GUAM	SRF, SUBIC BAY	MCAS, CHERRY POINT	NADC, JOHNSVILLE	NAF, INDIANAPOLIS	NAMC, PHILADELPHIA	NAS, AGANA	NAS, ALAMEDA	NAS, JACKSONVILLE	NAS, LAKEHURST	NAS, NORFOLK	NAS, PATUXENT RIVER	NAS, PENSACOLA	NAS, QUONSET POINT	NAS, SAN DIEGO	NOL, WHITE OAK	NOP, FOREST PARK	NOP, LOUISVILLE	NOP, YORK	NOTS, CHINA LAKE	NPP, INDIAN HEAD	NWP, WASHINGTON	PWC, GUAM	PWC, NEWPORT	PWC, NORFOLK	PWC, PEARL HARBOR	PWC, SUBIC BAY	NS, KEY WEST	MCSUPCEN, BARSTOW	NRL, WASHINGTON	NSD, GUAM					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
1. AIRCRAFT INSTRUMENT MECHANIC																X			X		X	X		X	X	X	X	X																					
2. AIRCRAFT LAUNCHING & ARRESTING DEVICES MECHANIC																			X																														
3. AIRCRAFT MECHANIC (GENERAL)																X			X		X	X		X		X	X	X																					
4. AIRCRAFT MECHANIC (MOTOR)																X			X		X	X		X		X	X	X																					
5. AIRCRAFT MECHANIC (ORDNANCE)																						X		X	X		X	X																					
6. AIRCRAFT MECHANIC (PNEUMATIC SYSTEMS)																X																																	
7. AUTOMOTIVE MECHANIC			X	X				X	X	X	X	X	X			X			X	X	X	X			X	X							X	X		X	X	X		X	X		X						
8. AUTOMOTIVE MECH. (BODY & FENDER)																																				X													
9. BLACKSMITH (OTHER FIRES)			X	X	X	X	X	X	X	X	X	X	X		X																																		
10. BOATBUILDER		X	X	X	X	X	X	X	X	X		X	X		X																																		
11. BOILERMAKER			X	X	X	X	X	X	X	X		X	X		X																			X	X	X					X								
12. CARPENTER			X								X	X	X			X			X		X	X			X	X		X	X				X	X	X	X	X	X	X		X		X						
13. CENTRAL OFFICE REPAIRMAN																																							X										
14. COPPERSMITH			X	X	X	X	X	X	X	X	X	X	X																						X						X		X						
15. DIESEL ENGINE MECHANIC																																				X													
16. ELECTRICIAN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X					
17. ELECTRICIAN (AIRCRAFT)																X			X		X	X	X	X	X	X	X	X																					
18. ELECTRICIAN (LINEMAN)																																	X			X						X							
19. ELECTRICIAN (POWER PLANT)							X				X																									X													
20. ELECTRICIAN (TELEPHONE)																																				X													
21. ELECTRONICS MECHANIC		X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X	X	X	X	X	X	X	X	X			X		X						X	X	X						
22. ELECTRONICS MECHANIC (MAINTENANCE)																												X														X							
23. ELECTROPLATER												X				X			X		X	X		X	X	X	X	X	X		X				X														
24. FIRE CONTROL MECHANIC			X					X	X			X	X					X						X																	X								
25. GLASS APPARATUS MAKER																													X														X						
26. GRAPHIC ARTS MECHANIC																			X																														
27. GYROCOMPASS MECHANIC																																									X								
28. HEAT TREATER (AVIATION)																			X					X																									
29. HEAVY DUTY EQUIPMENT MECHANIC										X																										X		X	X	X									
30. INSTRUMENT MAKER			X	X	X				X	X		X	X																																				
31. INSTRUMENT MECHANIC (GENERAL)										X																																							
32. JOINER			X	X	X	X	X	X	X	X	X	X	X	X					X			X													X						X								
33. LETTERER AND GRAINER																													X																				
34. MACHINIST	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X			X		X		X	X					
35. MACHINIST (MAINTENANCE)			X			X	X		X	X			X		X					X													X							X		X							
36. MACHINIST (MARINE)		X	X	X	X	X	X	X	X	X	X	X	X		X																		X								X								
37. MASON (BRICK OR STONE)																																			X														
38. METAL FABRICATOR																			X												X																		
39. METALSMITH (AVIATION)																X					X	X	X	X	X	X	X	X																					
40. MODELMAKER (NON-METAL)	X																																																
41. MOLDER			X	X		X	X	X	X	X	X	X							X																X														
42. OFFICE MACHINE REPAIRMAN																																				X													
43. PAINTER			X	X	X	X	X	X	X	X	X	X	X		X	X			X	X													X	X	X	X		X			X		X						
44. PAINTER (AIRC. FINISH & INSIGNIA)																X								X																									
45. PATTERNMAKER			X	X	X	X	X	X	X	X	X	X			X				X																X								X						
46. PIPE COVERER & INSULATOR			X	X	X	X	X	X	X	X	X	X																					X																
47. PIPEFITTER		X	X	X	X	X	X	X	X	X	X	X	X		X	X						X							X				X	X	X	X	X	X			X	X							
48. PLUMBER			X	X	X		X			X	X	X	X			X			X	X	X	X				X		X	X				X		X	X	X		X		X	X	X	X					
49. PRECISION LENS & PRISM & TEST PLATEMAKER																																			X														
50. RADIO MECHANIC																X			X		X	X		X		X	X	X																					
51. REFRIG. & AIR COND. MECHANIC			X	X	X			X	X							X		X		X		X				X			X				X		X	X			X	X	X	X	X	X					
52. RIGGER			X	X	X	X	X	X	X	X	X	X	X		X																			X							X								
53. ROCKET PROPULSION MECHANIC																																	X																
54. SAILMAKER			X	X	X	X	X	X	X	X	X	X	X		X																										X								
55. SHEETMETAL WORKER		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X				X		X	X		X		X	X	X	X		X	X	X	X	X	X						
56. SHIPFITTER		X	X	X	X	X	X	X	X	X	X	X	X		X																										X								
57. SHIPWRIGHT		X	X	X	X	X	X	X	X	X	X	X	X																						X														
58. TEST MECHANIC (EXPERIMENTAL AIRCRAFT ENGINES)																			X																														
59. TEST MECHANIC (EXPERIMENTAL AIRCRAFT STRUCTURE)																			X																														
60. TOOLMAKER			X	X			X			X	X	X	X			X		X	X			X									X		X		X														
61. WELDER			X	X	X	X	X	X	X	X	X	X	X																X				X		X					X	X								
62.																																																	
63.																																																	
64.																																																	
65.																																																	

Table III - Activities Authorized to Conduct Apprentice Training by Trades, as of 15 July, 1961

(Navy Civilian Personnel Instruction 410, Section 10-14, a, p. 88.).

[illegible]

employing journeymen in apprenticeable trades but not already authorized to provide training, may request authorization to establish such training if an analysis of the above indicates a need for such a program and the capacity to carry it out.

Once an activity has determined to establish an apprentice training program, it is necessary to estimate the number of apprentices that should be inducted each year. These are factors that effect this decision:

(1) The long range outlook for the workload of the activity;

(2) The requirements for journeymen in each of the apprenticeable trades considering attrition (including retirements);

(3) The number of journeymen to be obtained by means other than apprenticeship;

(4) The need for sufficient apprentices to assure an adequately trained nucleus of potential key employees and supervisors to support any necessary sudden expansion of work force in time of emergency;

(5) The probable attrition of apprentices;

(6) The number of apprentices needed in the graduating group, considering attrition among graduates;

(7) The ratio of apprentice hires to journeymen that is required to maintain apprentice training;

(8) Adjustment in the number of apprentices to be inducted for the particular year, by trades giving consideration to the anticipated need for journeymen at the close of

the four-year apprenticeship. Although there is no maximum ceiling on the number of apprentices at any one location, the minimum number should provide an input of at least 2% to 3% of the journeymen in apprenticeable trades.

III. ORGANIZATION

It is the purpose of the Navy apprentice training program to pattern the curriculum around a mixture of shop training under qualified instructors and school instructors similarly qualified in their field. Approximately four weeks are spent in shop work for each one week spent in related training.

The training should be under the direction of an Apprentice Supervisor who preferably is a product of an apprentice school. He should have had trade experience (usually four years is sufficient); should have completed an instructor training course (30 hours); and he should have demonstrated his ability to organize trade material for instructional purposes.

Shop instructors are artisans who have served a regular apprenticeship in the trade or have obtained sufficient training otherwise to qualify them, and who have had experience in the trade they teach. A course of instruction in instructor training is also essential.

Related information instructors are most frequently obtained from the local school districts. In this case the instructor must be qualified under the school requirements as well as the apprenticeship training requirements.

The apprentice serves four years of training which will provide him with approximately 8,000 hours of shop and related information indoctrination.

IV. SELECTION OF APPRENTICES

To be eligible for the written examination given by the Civil Service Commission, applicants for apprentice training must be between the ages of 16 to 21 years. To be eligible for appointment the applicant must pass the written examination with a grade of 70 or higher. Furthermore, to be eligible for certain trades, requiring considerable use of mathematics (such as machinist), applicants must pass an additional test in algebra and geometry. Civil Service rules for appointment are followed in selecting the desired number of apprentices. Exceptions may be made for veterans with respect to age limits and test scores.

V. SHOP AND RELATED TRAINING

A schedule of shop training (not to be confused with related information training) is made for each apprenticeable trade. This schedule is a plan for the rotational training throughout all of the work experience the apprentice should require to become a well rounded craftsman.

The work experience plans are combined into broad areas of training according to the work performed. These areas are then systematically and progressively arranged into individual work experiences or elements. As an example, the

sewage systems would be an area of training for pipefitter. The installation, maintenance and repairing of sewage lines and equipment would be some of the elements of shop training under this one area.[28] The apprentice receives shop training four out of every five weeks. In one year he will complete 1600 hours of instruction in the shop.

The related training, which the apprentices receive during the one week in five, is a carefully organized part of the program using books, laboratories, individual lesson sheets and lectures. The related instruction consists of specific information or knowledge that is essential to the apprentice for the full mastery of his trade. These subjects include:

(1) Trade Theory
(2) Trade Mathematics
(3) Trade Science
(4) Trade drawing and Blueprint Reading
(5) Applied English
(6) Organization and Management

A total of 400 hours per year are devoted to this area, and the level of instruction will normally fall within the range of the 10th to 14th grade work.

Table IV, page 54 is a typical training plan for an Electronics Mechanic Apprentice and shows the broad allocation of time to the various areas and elements of his related information training.

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[28] See Appendix C for pipefitter apprentice shop training outline, pp.129 to 133.

ELECTRONICS MECHANIC APPRENTICE TRAINING PLAN

SCHEDULE OF RELATED INFORMATION TRAINING

SUBJECT	Total Hours	Hours Per Year of Apprenticeship			
		1st	2nd	3rd	4th
Trade Theory *	648	168	168	160	152
Trade Mathematics	376	112	112	80	72
Trade Science *	160	0	0	64	96
Trade Drawing and Blueprint Reading	192	64	64	40	24
Applied English	160	40	40	40	40
Organization and Management	64	16	16	16	16
Total Hours Scheduled	1600	400	400	400	400

* Only enough time has been scheduled in Trade Science to cover those areas of instruction which are not a part of the Trade Theory curriculum.

Table IV - Electronics Mechanic Apprentice Training Plan
Schedule of Related Information Training
(Navy Civilian Personnel Instruction 410, Section 10-14,c,p.91)

When the number of apprentices being scheduled to receive related information training is too small to make instruction by formal classroom arrangement economically or practically feasible, another plan, such as one of the following, can be adopted: (1) combined-course training for a group of allied trades; (2) supervised study basis; (3) correspondence courses; or (4) use of a nearby U. S. Government facility or use of a non-Government facility.

VI. APPRENTICE PROMOTION POLICY

Every apprentice upon entering on duty is rated as apprentice in the trade he is studying (i.e. apprentice pipefitter) and he is assigned a class, such as fourth class through first class. A beginning pipefitter trainee would then be classified apprentice pipefitter fourth class and would be promoted through the four classes yearly as he completes his necessary training. This normally will require the full 1600 hours of shop work and 400 hours of related training for each years advancement.

Unsatisfactory performance of apprentices is handled in accordance with Civilian Personnel Instruction (230.10) which states that an apprentice may be dropped if he has two unsatisfactory quarterly grades in any one year.

Advanced training is also encouraged and apprentices who demonstrate superior ability may be permitted to spend part of their time in engineering, planning and production control. Advanced credit earned before entering apprentice training may be allowed up to a maximum of two years. The

Navy Department requires each apprentice to complete satisfactorily at least two full years in active Navy apprenticeship, including specific application of his selected trade within the Navy before he will be eligible to receive a Navy apprenticeship certificate.[29]

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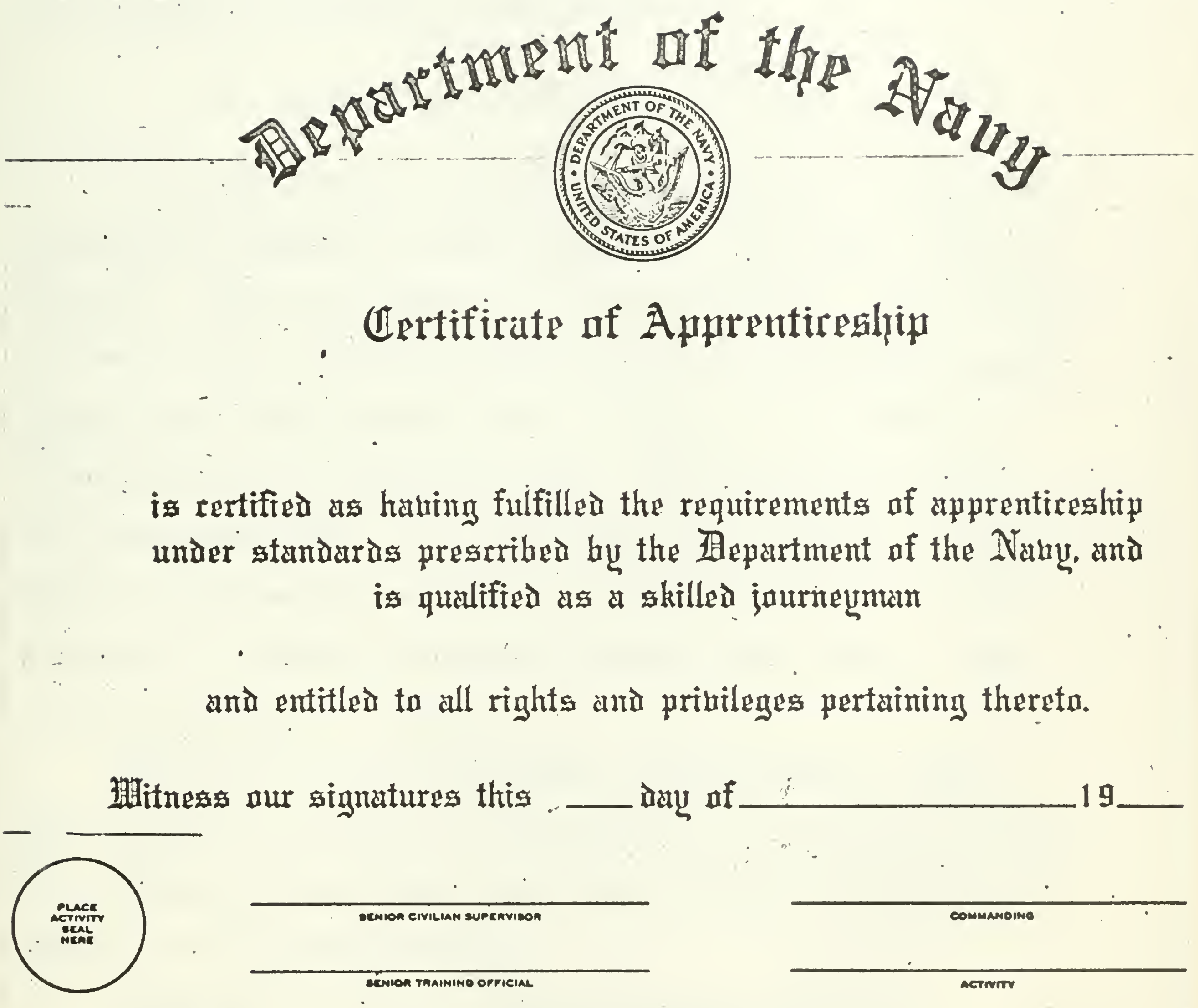
[29] See Fig. 9. p. 57.



Department of the Navy

Certificate of Apprenticeship

is certified as having fulfilled the requirements of apprenticeship under standards prescribed by the Department of the Navy, and is qualified as a skilled journeyman

and entitled to all rights and privileges pertaining thereto.

Witness our signatures this ____ day of ________________ 19___

PLACE ACTIVITY SEAL HERE

SENIOR CIVILIAN SUPERVISOR

COMMANDING

SENIOR TRAINING OFFICIAL

ACTIVITY

Fig. 9 - Naval Apprentice Graduate Certificate

(Navy Civilian Personnel Instruction 410, Section 10 - 14, g, p. 97.)

SECTION VI

FINDINGS

This section presents the findings of the questionnaire survey conducted, review of the literature and data collected through interviews or correspondence.

I. VALIDITY AND RELIABILITY OF DATA

The questionnaire response was excellent. Of the 162 activities requested to participate in the survey, 117 replied.[30] Data was supplied by 100 activities. The other 17 activities that replied consisted of: (1) Activities whose public work functions had been or were in the process of transferring to other activities; (2) Activities with no civilian employment; (3) Activities not desiring to participate in the survey either due to the considerable effort required to collect the data or because they did not consider the survey of value.

The 100 activities providing the data varied over a wide range with respect to the number of journeymen employed. For purposes of analysis, they were divided into four equal groups of 25 activities each:

Group No. 1 - 10 to 37 journeymen per activity

Group No. 2 - 37 to 95 journeymen per activity

Group No. 3 - 97 to 189 journeymen per activity

Group No. 4 - 195 to 705 journeymen per activity

A total of 13,275 journeymen are reported on by this study -

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[30] See Appendix A for a complete listing of replying activities, pp.97 to 108.

a total estimated by the writers to be approximately 50% of all public works craftsmen employed by the Navy within the continental United States and Hawaii.

Wide distribution was also achieved geographically and by type of activity. Ten general categories of activities are represented as shown by Table V, page 60. Most represented are Naval Air Stations - 31%. All activity types are represented in more than one group except Naval Communications Activities (small by nature) and Public Works Centers (large by nature). Geographically, at least 10 states and 5 areas are represented in each group as shown by Table VI, page 61. The state with the most activities is California whereas the most represented area consists of the Southern States. In total, 28 states and the District of Columbia are represented.

II. THE PROBLEM OF AGE

The Department of Labor has conducted an extensive survey of man-power needs projected through 1970.[31] Concern was expressed over the fact that 41% of the nation's skilled craftsmen were over 45 years of age and that this percent was expected to remain at this high level through the 1960's. Question two of the questionnaire conducted as a part of this study requested a count of journeymen by five year age groups.[32] The findings as shown by Figure 10, page 62 were:

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[31] U. S. Department of Labor, Manpower: Challenge of the 1960s, (Washington: Government Printing Office, 1959), p. 18.

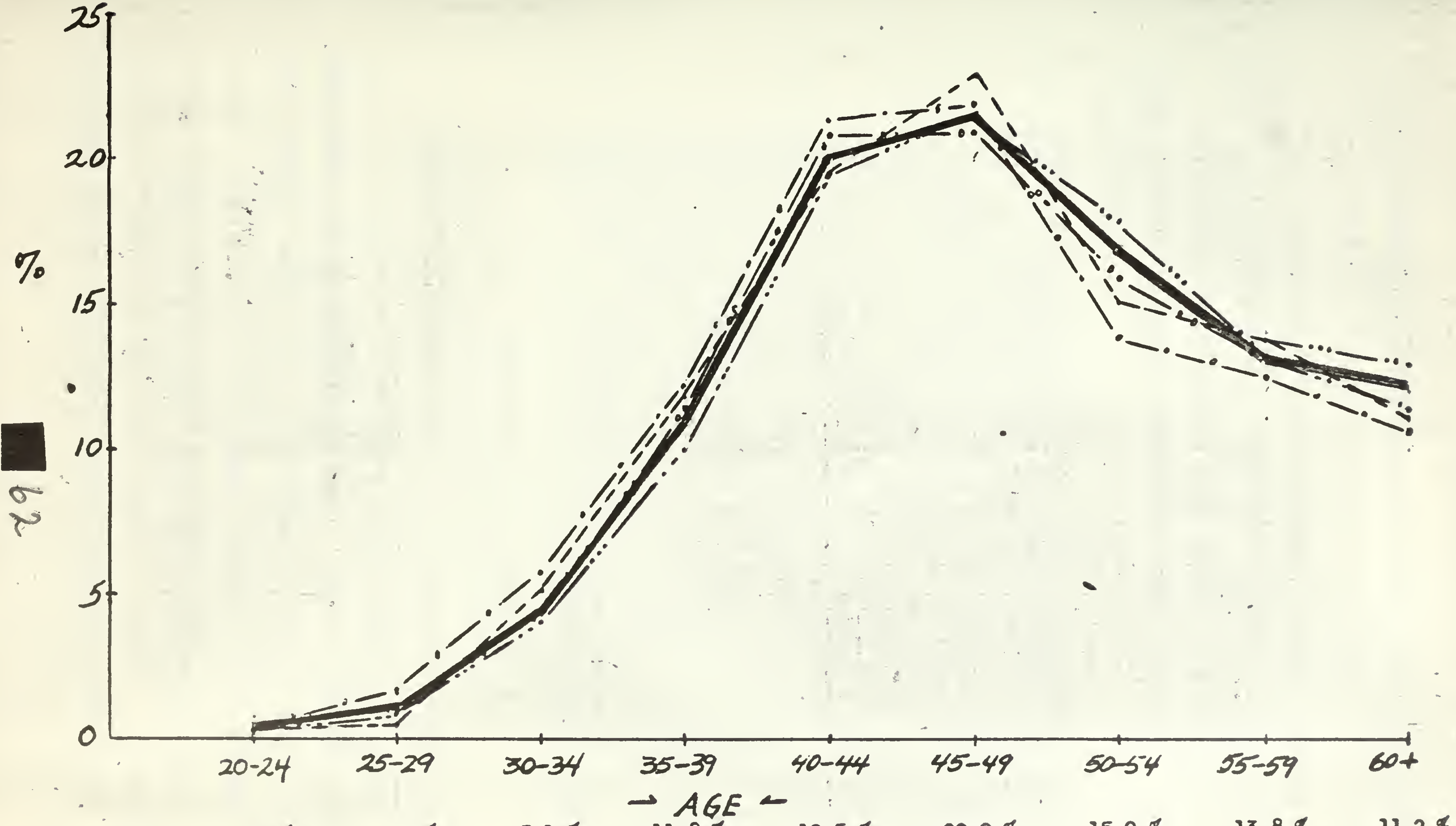
[32] See Appendix B for basic data, pp. 109 to 113.

TABLE V - REPLIES BY TYPE OF ACTIVITY

		GROUP				
		1	2	3	4	Total
1.	Personnel/Training Activity	3	1	1	2	7
2.	Supply Center or Depot	2	2	4	1	9
3.	Research/Development Activity	4	2	2	1	9
4.	Admin/Operational Activity	2	1	2	4	9
5.	Communications Activity	3	0	0	0	3
6.	Air Station	6	12	6	7	31
7.	Hospital	2	3	2	0	7
8.	Ammunition Depot/Production Plant	3	3	5	2	13
9.	Shipyard	0	1	3	4	8
10.	Public Works Center	0	0	0	4	4
	Total	25	25	25	25	100

TABLE VI - Geographical Distribution of Replies

	GROUPS				
	1	2	3	4	Total
Hawaii	1	1	1	1	4
Pacific Coast States	2	5	10	10	27
Mountain States	0	2	1	0	3
Southwest States	2	1	1	0	4
Midwest States	3	4	2	0	9
Southern States	8	6	8	8	30
Northeast States	8	5	4	3	20
District of Columbia	1	1	0	1	3
Total	25	25	25	25	100
Number of States Represented	18	14	16	10	58



Group 1 - - - 0.2 %	0.5 %	5.1 %	11.8 %	19.5 %	22.9 %	15.0 %	13.8 %	11.2 %
Group 2 —· 0.3 %	1.7 %	5.7 %	12.2 %	21.3 %	21.9 %	13.8 %	12.5 %	10.6 %
Group 3 —·· 0.4 %	1.1 %	4.4 %	11.5 %	20.8 %	20.8 %	15.9 %	13.1 %	11.9 %
Group 4 —···0.2 %	1.0 %	4.1 %	10.0 %	19.5 %	21.4 %	17.9 %	13.1 %	12.8 %
Total Average .3 %	1.1 %	4.4 %	10.8 %	20.1 %	21.4 %	16.8 %	13.0 %	12.1 %

Fig. 10 JOURNEYMEN BY AGE GROUPS

1. Percent of craftsman over 45 years of age- 63.3%

2. Percent of craftsmen over 40 years of age- 83.4%

3. Percent of craftsmen under 30 years of age- 1.4%

4. Age distribution did not vary by activity size.

The following excerpts from survey participating activities correspondence examplifies the concern at the operating levels:

> From available statistics, 90% of the per diem personnel in this department are over 40 years of age and most of these have 15 or more years of service---The problem of providing future journeymen is becoming increasingly critical---Due to the high average age of personnel an apprentice program is highly desirable--You will note that our average and median ages are both 51 years. Unless we can be more successful in pumping in new blood, we will have a real problem as our work force ages.---The main problem from a labor force standpoint is to obtain younger men, since over half of our force exceeds 50 years in age. Almost a third of the men are 55 or over. This condition has resulted primarily from World War 11 hiring of older men plus severe reduction in forces over the years. The younger men have been vulnerable to such RIFs.--The majority of our personnel entered Federal service in World War 11.---It is to be noted that the figures are based on journeymen only and do not include supervisors. If supervisors had been included, the average age of the shop personnel would be much higher.

III. THE PROBLEM OF ATTRITION

In 1959 a national study of journeymen losses was completed by Kaylor and Hamburger which appears in their book, Education For An Industrial Age. Their findings were that the average tenure of a journeyman is 28 years and that the annual losses due to retirement, disability and death is 3.6%. They also concluded that this journeyman loss rate would be valid for the near future. The rate is currently accepted by the California Apprenticeship Council as

realistic. Question three of the questionnaire conducted as a part of this study requested a projection of anticipated journeymen losses by fiscal year, between 1965 and 1969. The findings as shown by Figure 11, page 65 were:

1. The average annual journeymen loss for the total population was 9.5%.

2. The total anticipated losses over the five year period were projected at 47.6% in a population 13,275.

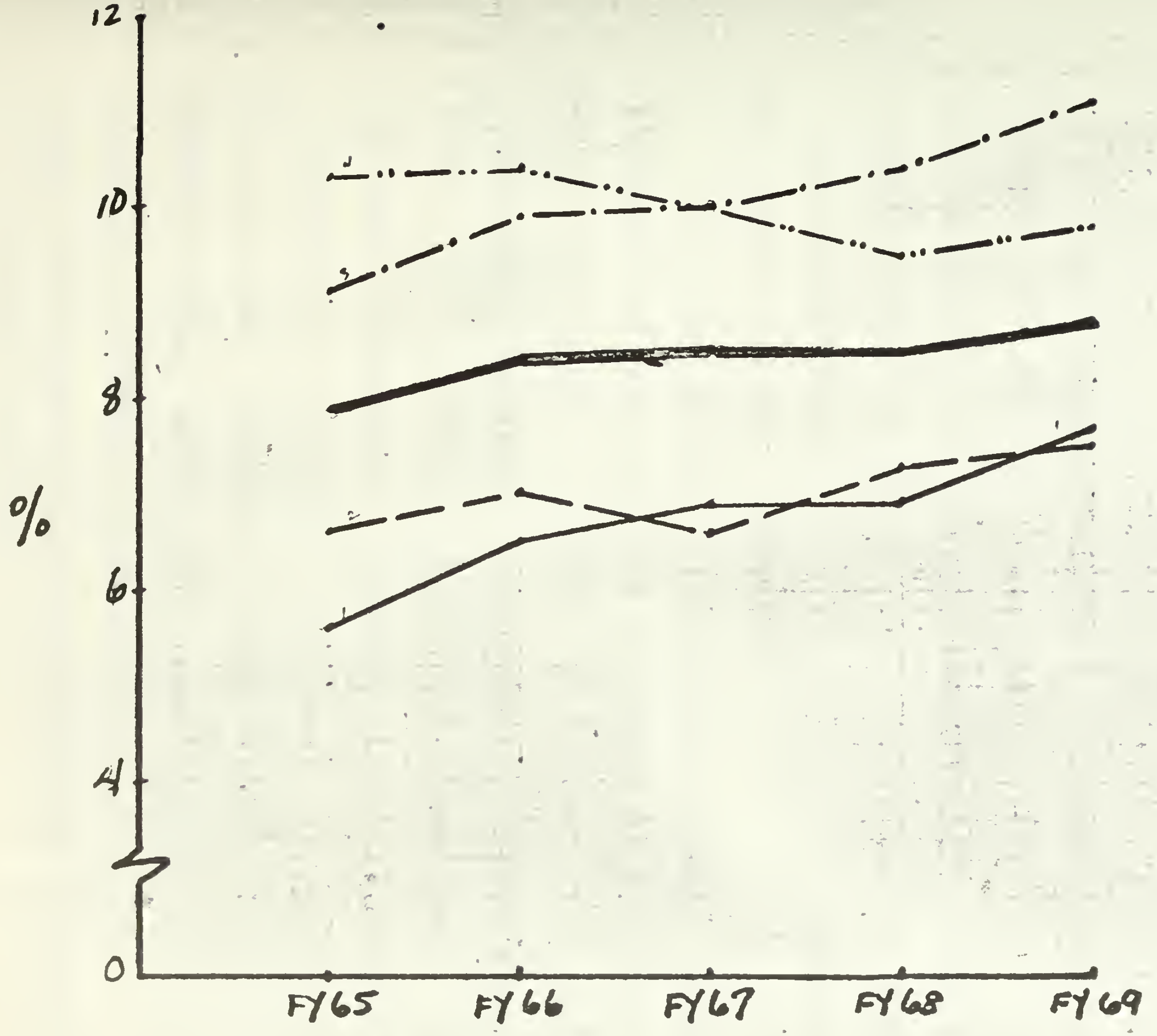
3. The loss rate steadily increased with time for Groups No. 1, 2 and 3, whereas it decreased slightly for Group 4.

4. The average loss rate for Group No. 3 and 4 was considerably higher for all periods than that of Groups No. 1 and 2.

A number of activities were subsequently requested to verify the extremely high loss rate reported. The following are excerpts from their replies:

> During first two years of operation (FY 62, FY 63), Public Works lost 44 employees.---We anticipate losing a substantial percent of our journeymen in the next five years. This is largely attributable to reductions in forces, imposed between 1959 and 1962, which removed all but our most senior employees.---We have practically no input of young men because the local area offers very little future in growth, pay scales in general are low and the young people leave the area.--We find that we have been, and continue to be forced with a spriling retirement rate as evidence by the number of journeymen indicated.---Fiscal Year 1965 may show an increase in separations equal to or exceeding Fiscal Year 1963.--- At present our average age in all ungraded positions in Shop Division has been high resulting in over 60 retirements in the past year. Add to this other causes for separation, makes our attrition rate run to 85 for the year.

Even with substantiations as stated above, the loss rates as shown were based only on the activities whose data



	FY65	FY66	FY67	FY68	FY69
Group 1 ———	5.6 %	6.5 %	6.9 %	6.9 %	7.7 %
Group 2 — — —	6.6 %	7.0 %	6.6 %	7.3 %	7.5 %
Group 3 —·—	9.1 %	9.9 %	10.0 %	10.4 %	11.1 %
Group 4 —··—	10.3 %	10.4 %	10.0 %	9.5 %	9.8 %
Average ▬	7.9%	8.4%	8.5%	8.5%	8.8%

Fig. 11 EXPECTED LOSSES FISCAL YEARS 1965–69

was within ± 2 standard deviations of the mean loss rates for their respective groups. This resulted in more conservative rates than would have otherwise been shown.[33] In doing so, data from five activities was excluded. Their respective total loss rate for the next five years were 100%, 87.5%, 115.4%, 113.2%, and 155.0%.

IV. THE PROBLEM OF RECRUITMENT

Section IV attempted to show that historically, concern of lack of technically trained craftsmen has had a tendency to cycle. In fact, it would appear that this cycle parallels the duration of various technological ages or periods in general. The late 1930s was the last period, prior to recent years, in which concern over the lack of craftsmanship training gained national prominence.

Just how serious is the problem today? Figure 12, page 67 shows the expected rate of growth of the major industries in the United States during the 1960s. It is noted that the construction industry is expected to expand almost twice as fast as industry in general. The construction industry is the major consumer and competition for the majority of journeymen in the trades this paper is concerned with (i.e. Electricians, Carpenters, Plumbers etc.) Automation is slowly turning the manufacturing industry into factories of automated equipment and maintenance craftsmen(i.e., Machinists, Refrigeration and Air-conditioning Mechanics, Heavy Duty Equipment Mechanics etc.)

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[33] See Appendix B for basic data, pp. 114 to 117.

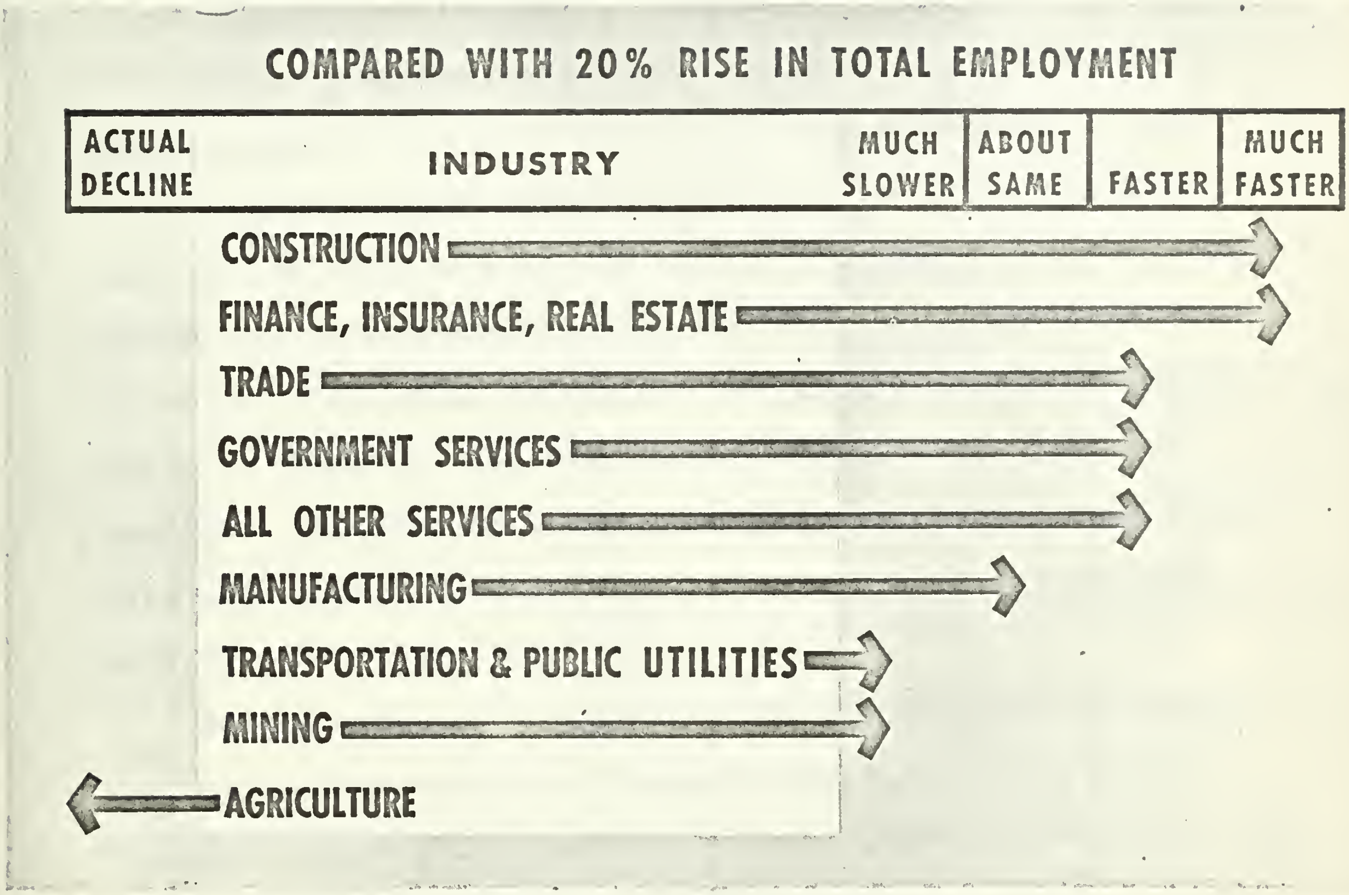

Fig. 12 - Expected Growth Rate During the 1960s

(U.S. Department of Labor, Manpower Challenge of the 1960s, Washington; Government Printing Office, 1959, p. 9)

This, of course, is not necessarily a problem if apprentice training is expanding at an equal rate, both in and outside the Navy. Unfortunately it is not. Construction trades apprentice program graduates have declined as follows:

1954	1956	1958	1960	1962
156,000	112,619	108,814	102,963	100,751

The U. S. Labor Department's Bureau of Apprenticeship and Training states that one of the most important of the basic trades, Carpenters, is graduating so few apprentices that it can replace only 14% of the journeymen lost through deaths and retirements and will be able to supply fewer than 5% of the additional Carpenters the future growth of industry will require. The same report stated . . . "the construction industry as a whole is producing through apprenticeship only 10% of the additional journeymen it will need by 1970."[34]

In the midst of a general slump in apprentice training, the United Association of Plumbers and Pipefitters and the National Construction Association have awarded $269,150 to 29 local unions for training. The educational training program of the U. A. is one of the largest and most elaborate of any trade union in the nation. But the union is barely holding its own in the number of apprentices enrolled.[35]

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[34] Engineering News Reports, "Carpenters Face Shortage of Journeymen", 169: 74, December 13, 1962.

[35] Engineering News Record, "Training; A Dommed Crusade?" 162: 102, March 26, 1959.

The writers have included an extensive bibliography with this paper. Most of the periodical articles are repititious with concern over the above problem and every basic trade is included.

Question seven of the questionnaire conducted as a part of this study requested a ranking of the method of recruiting journeymen. This data [36] was then assigned a weight equal to the journeymen population of the activity. From this the present recruitment sources were determined percentagewise for total population and each group. The findings as shown by Figure 13, page 70 were:

1. Apprentice programs provided only 10.7% of journeymen at present.

2. Only 47.6% of all journeymen recruited have been formally trained.

3. The above percentages improve (increase) as the activity's journeymen population increases.

4. There is a 7% preference to promoting journeymen helpers to recruiting personnel with general experience.

5. Although 52.4% of personnel being recruited into the journeyman category have not received formal training, there is a surprising lack of concern. The reason is apparent and is discussed in the following subsection.

V. THE PROBLEM OF SUB SPECIALIZATION

An article in Engineering News Report in December 1962 pointed out a problem developing from the shortage of fully

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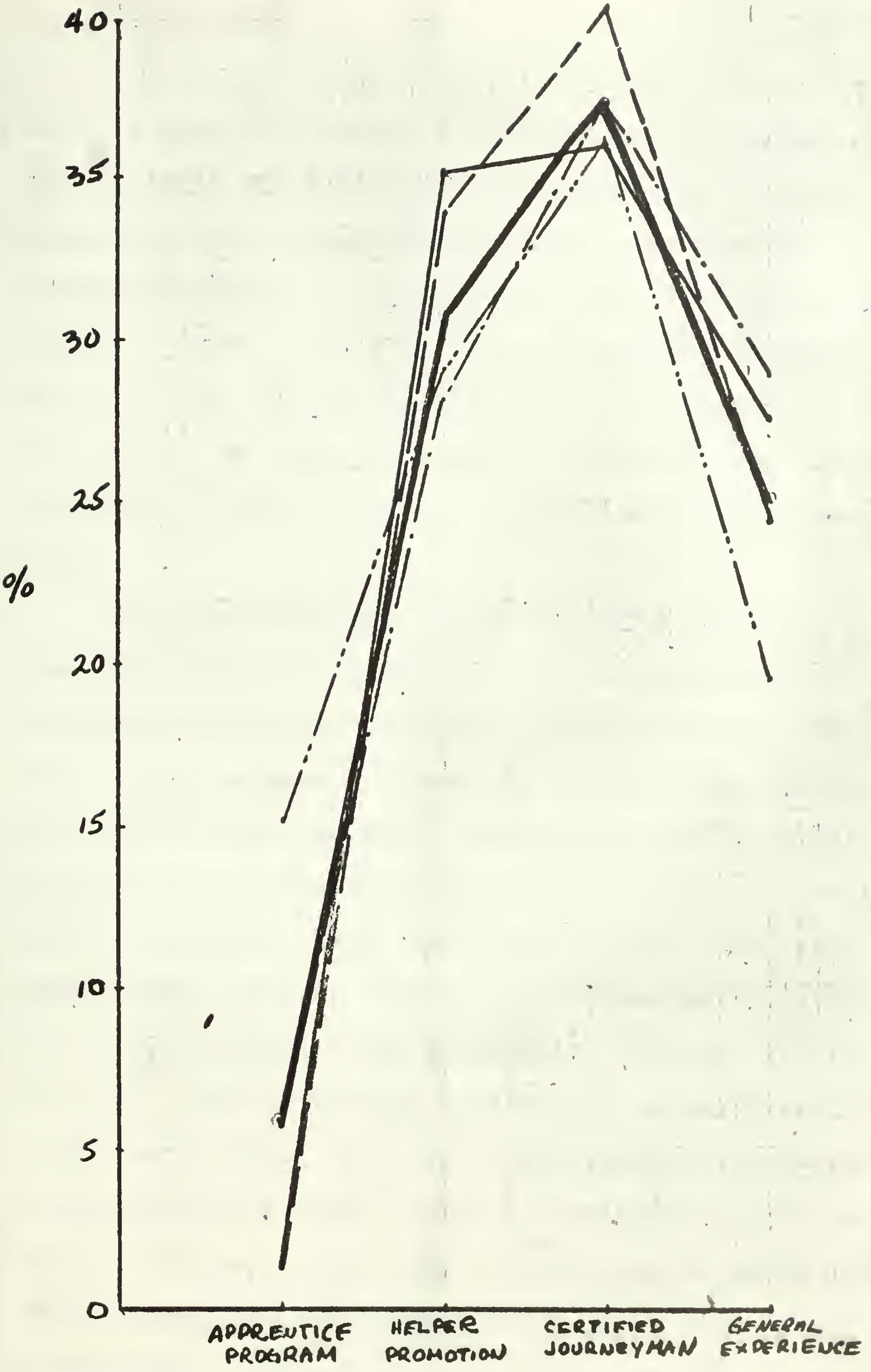
[36] See Appendix B for basic data, pp. 118 to 121.



Group 1	———	1.3 %	35.1 %	36.0 %	27.6 %
Group 2	— — —	1.5 %	33.9 %	40.3 %	24.3 %
Group 3	— · —	5.7 %	28.2 %	37.4 %	28.7 %
Group 4	— ·· —	15.1 %	29.2 %	36.2 %	19.5 %
Average	▬▬▬	5.9%	31.6%	37.5%	25.0%

Fig. 13 METHOD OF RECRUITMENT

qualified (apprentice trained) journeymen which can be seen on an increasing scale today. It stated, "More attention must be paid to rotation of apprentices to prevent specialization...The development of apprenticeship and its successful operation has been hampered, for example, by the growth of specialty subs for such work as flooring and roofing..." Question four of the questionnaire conducted as a part of this study requested a count of journeymen by specific trade. As shown by Table VII, page 72 and Figure 14, page 73, 15 trades constituted 65.8% of the total population.

Sub specialization in lieu of fully trained craftsmen was very apparent.[37] For example, activities with the classification of Refrigeration and Air Conditioning Mechanic also reported personnel classified as Refrigeration Mechanic, Air Conditioning Mechanic, Dehumidification Mechanics etc. Activities reporting pipefitters also reported sprinkler system mechanics. Many activities, as per the initial example stated, had in addition to carpenters - roofers, joiners, cabinetmakers, wood and plastic workers, linoleum layers etc. This increasing subdivision of basic trades both within and without the Navy is symptomatic of decreasing availability of the well trained journeyman in the basic trades. In particular, the activities with small numbers of journeymen can ill afford the loss of flexibility and consequently the loss in productivity that goes with subdividing basic crafts into semiskilled classifications.

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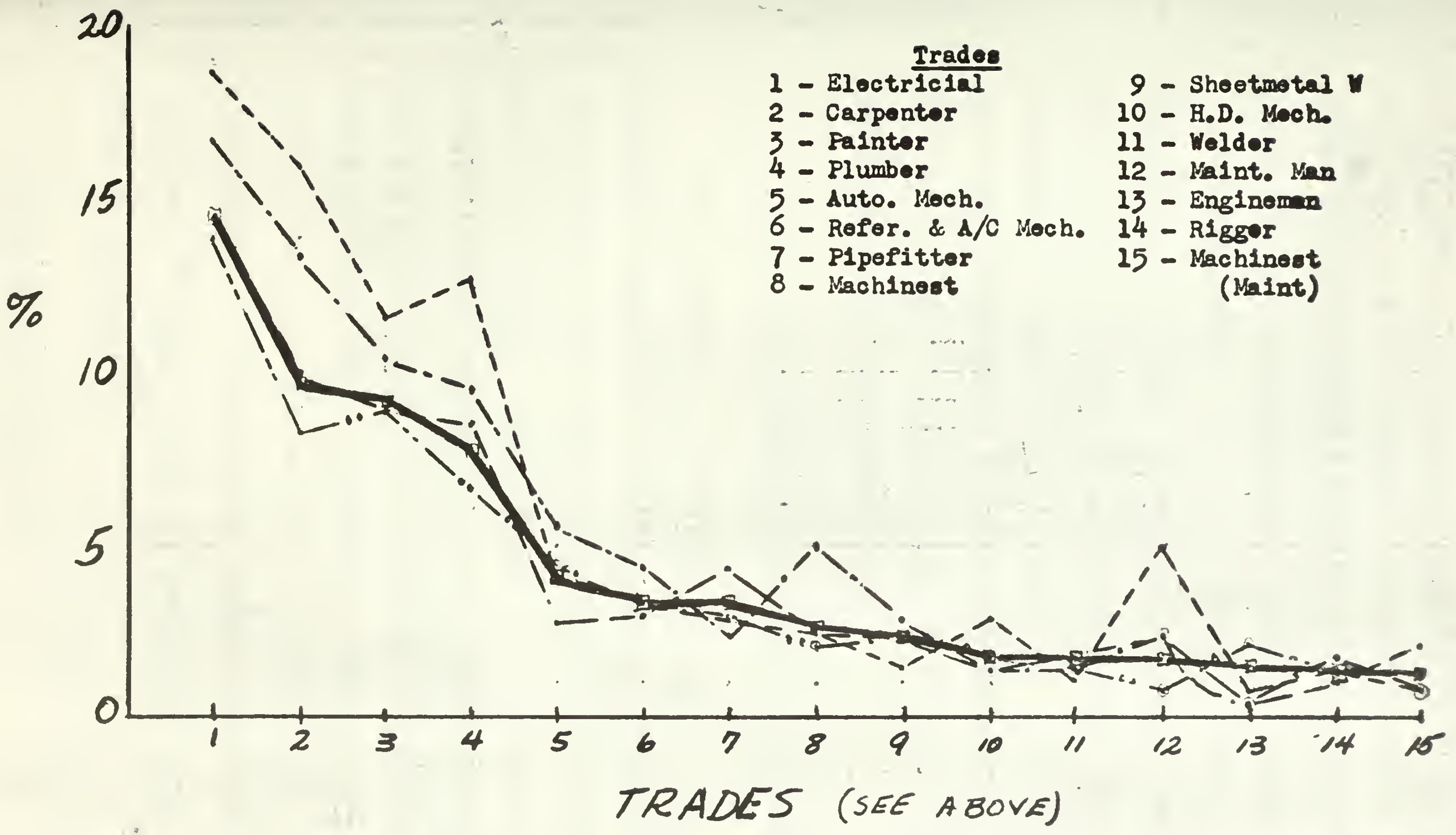
[37] See Appendix B for a complete listing of crafts, trades and classifications reported, pp. 122 to 124.

Group	Electrician	Carpenter	Painter	Plumber	Auto Mechanic	Refer & A/C	Pipefitter	Machinist	Sheetmetal	Hv Duty Mech.	Welder	Maint. Man	Enginemen	Rigger	Mach. Maint.
1	120	103	75	82	27	22	19	16	10	19	7	32	5	9	5
2	247	198	154	142	83	66	34	75	42	28	29	36	5	25	13
3	483	335	294	284	89	100	143	79	77	49	63	84	10	38	78
4	1078	649	691	515	346	258	242	170	188	132	116	62	174	112	76
Total	1928	1285	1214	1023	545	446	438	340	316	228	215	214	194	184	172
	14.5%	9.7%	9.1%	7.7%	4.1%	3.4%	3.3%	2.6%	2.4%	1.7%	1.6%	1.6%	1.5%	1.4%	1.3%

Table VII - Number of Journeymey by Trades



GROUP 1 - - - -	18.6%	15.9%	11.6%	12.7%	4.1%	3.4%	2.9%	2.5%	1.5%	2.9%	1.1%	5.0%	0.8%	1.4%	0.8%
Group 2 —·—	16.6	13.3	10.3	9.5	5.6	4.4	2.3	5.0	2.8	1.9	1.9	2.4	0.3	1.7	0.9
Group 3 ——·	14.5	10.0	8.8	8.5	2.7	3.0	4.3	2.5	2.3	1.5	1.9	2.5	0.3	1.1	2.3
Group 4 —··	13.8	8.3	8.9	6.6	4.4	3.3	3.1	2.2	2.4	1.7	1.5	0.7	2.2	1.4	1.0
Average ━━━	14.5	9.7	9.1	7.7	4.1	3.4	3.3	2.6	2.4	1.7	1.6	1.6	1.5	1.4	1.3

Fog. 14 JOURNEYMEN BY TRADES

A recent study by the Division of Apprenticeship Standards of the State of California indicated a 60% increase in productivity, a 67% decrease in turnover and a 70% decrease in absenteeism of the apprentice trained qualified craftsman compared to semiskilled and unskilled labor.[38]

A comparison of the training received by a pipefitter apprentice as shown on Appendix C pages 129 to 133 and the list of the pipefitter sub crafts reported, as shown on Appendix B, page 122 makes apparent that the basic crafts are being subdivided into semiskilled classifications. This in turn requires more personnel if total craft knowledge and experience is to be available.

VI. THE PROBLEM OF TRAINING AVAILABILITY

The Department of Labor, Bureau of Apprenticeship and Training conducted a pilot study of industrial training in the Trenton, New Jersey area during the first calendar quarter of 1959. The purpose of this survey of some 570 establishments employing four or more workers was to develop and test procedures to be used by the Bureau in a nation-wide study of training in industry. Mercer County was selected because of its wide variety of industrial activity. One of the results of that survey showed that the smaller an establishment the more likely it had apprentices. The results were as follows:[39]

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[38] See Figure 15, p. 75.

[39] Department of Labor, A Look At Industrial Training In Mercer Coutny, New Jersey, (Washington: Government Printing Office, 1959) p. 21.

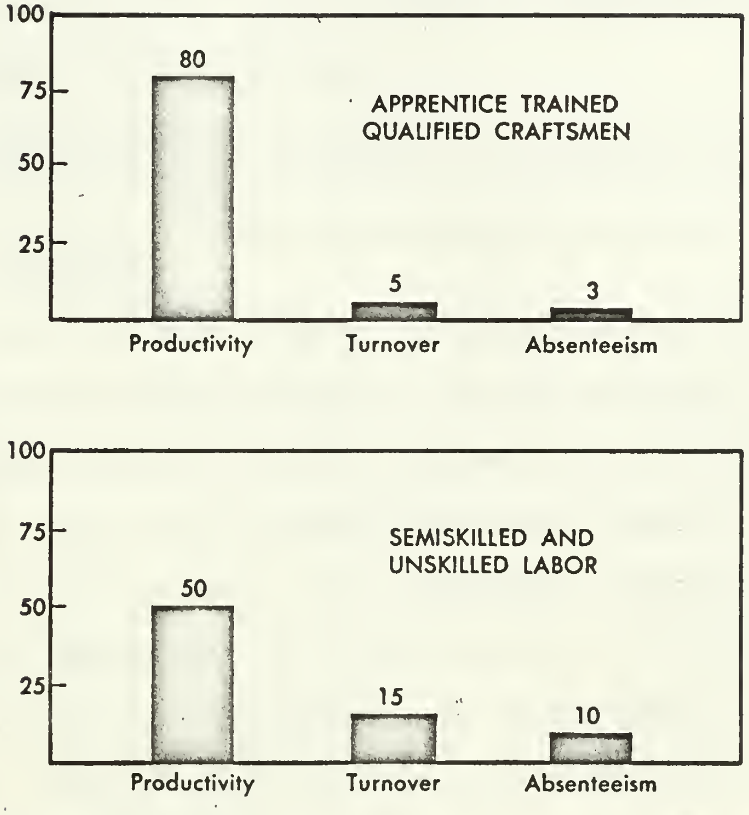

Fig. 15 - Productivity Results of Apprentice Training

(State of California, Craftsmanship Through Apprenticeship, 1963)

	Size of Firm (Craftsmen)		
	4 - 19	20 - 99	100 - over
No. of Firms Having Building or Metalworking Apprentice Programs.	115	69	47

Question five of the questionnaire conducted as a part of this study requested that activities having an apprentice program so indicate and that each trade apprenticed and its duration be provided. The findings as shown by Tables VIII and IX, pages 77 and 78 were:

1. The smaller an activity the less likely it had apapprentices. (Absolute reverse of the Mercer Study).
2. A total of 18% of the activities operate apprentice programs.
3. All programs were of a four year duration.

The above contradiction of the correlation between organizational size and active apprenticeship training is due in part to the lack of flexibility with respect to training apprentices in the Navy. The following statement by Dr. John S. McCauley, Chief of Research of the Bureau of Apprenticeship and Training, U. S. Department of Labor, shows how small organizations outside the Federal Government are solving the problem:[40]

> In sharp contrast to the large corporation, the small establishment often lacks the necessary resources to conduct planned training without outside help.[41] Since 98% of the business establishments in this country are

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[40] Louis Ruthenburg, Personnel, "The Crisis In Apprentice Training," July, 1959, p. 32.

[41] Lack of funds or personnel allowances was cited by practically all activities as the reason for not operating an apprentice program.

Table VIII - TRADES PRESENTLY BEING APPRENTICED

ACTIVITY NUMBER	Electrician	Machinist	Painter	Pipefitter	Carpenter	Electronics Mech.	Plumber	Welder	Refer. & A/C	Sheetmetal	Mach. Maint.	Auto. Mech.	Elec.(PowerPl.)
21	x	x											
29			x	x									
56	x	x			x	x	x	x					
59	x								x				
67	x			x			x		x		x		
72	x				x		x			x	x		
76	x	x			x								
82	x		x		x		x		x				
83	x			x	x				x	x			
85	x				x		x						
89	x	x		x	x		x		x	x			
92	x	x			x	x						x	
93													x
95							x					x	x
96	x				x								
97													x
99	x	x				x	x			x			
100 *	x	x	x	x	x				x	x			x
Total	14	7	3	5	10	3	8	1	6	5	2	2	4

* Note: Activity 100 also apprentices (1) boilermaker (2) joiner (3)plasterer (4) wharfbuilder (5)brickand stone mason (6) H.D. Mechanic

Table IX - Type of Activity With Apprentice Program

Activity Number	Research/Development Activity	Air Station	Supply Center/Depot	Ordnance Depot/ Production Plant	Shipyard	Admin/ Operational	Public Works Center
21	x						
29		x					
56			x				
58							
59				x			
63					x		
67			x		x		
69							
72	x				x		
73			x				
76		x					
82						x	
83				x			
85		x					
89		x					
92		x					
93					x		
95					x		
96		x					
97					x		
99	x						
100							x
Total	3	6	3	2	6	1	1

> small firms employing fewer than 100 workers,[42] this is an important factor in the national training picture. To organize effective training, small firms frequently require assistance of the government apprenticeship agencies,[43] vocational schools, and community organizations.
>
> A promising development for the small firm is the growth of community-wide training programs in which two or more establishments participate jointly. Such programs enable a group of employers usually in cooperation with a labor union to accomplish together what many would be unable to do individually.
>
> About 6,000 community-wide apprenticeship committees have been established throughout the country. Each of these committees sponsors an apprenticeship program in a single trade or group of related trades in which an average of approximately 25 employees participate. As a rule, apprenticeship committees have six members, three representing management and three organized labor. The committee plans apprenticeship programs, select apprentices, and determine when each apprentice has completed his term of training satisfactorily. Some committees also have organized special training programs to keep journeymen abreast of technological changes.
>
> There seems to be no reason why the organization that cannot undertake a training program of its own should not take advantage of these facilities. The fact that this is not being done on a large enough scale is a clear indication that management, by and large, is not sufficiently aware of the urgency of the program.

Question six of the questionnaire attempted to determine interest and participation at the activity level in formal skill updating programs. The results as shown by Table X, page 80 were:

[42] 52% of the activities in this study.

[43] Although excellent Federal, State, and city apprenticeship agencies exist throughout the nation and are willing to assist in developing apprentice programs, Naval Activities are forbidden to even discuss any aspect of apprenticeship training with them directly. See N.C.P.I. 410, paragraph 10-3. The writers verified the above by personal interviews at activities and state and local agencies.

ACTIVITIES UTILIZING SKILL UPDATING

Table X - SOURCES OF TRAINING

Activity Number	Manufactoring or Industry	Local School	Same Activity	Other Activity
2	x			
5	x			
7		x		
9			x	
15		x		
21		x		
26		x		
31	x			
35			x	
45		x		
50		x	x	
53		x		
55			x	
57		x		
58	x	x	x	
59	x	x		x
63	x	x	x	
66	x	x		
68		x		x
70		x		
71			x	
72		x		x
73		x		
81		x		
83			x	
90		x		
91		x	x	
92			x	
93			x	
94	x		x	
96		x	x	
97	x	x		x
98				x
99		x		
100		x	x	
Total	9	23	14	5

1. Twenty three percent of the activities encouraged their journeymen to take courses offered by local trade schools or at least were aware of their existance.
2. Approximately 25% of the activities in Group 1 and 2 and 50% of Group 3 and 4 were aware of skill updating programs in their vicinity.

A number of activities stated that no such programs existed near their activity, whereas, other activities located in the same area listed numerous schools and manufacturers that were providing courses. Several activities considered safety talks required enough time out of the work schedule without wasting additional time on training. At the same time, there is an increasing awareness outside the Navy to update skills in this era of rapidly changing technology. The following is only one example of many recent programs to update skills that appear to be passing the Navy by:

> A desire by unions and contractors to keep Electricians and Plumbers and Pipefitters attuned with their technologically fast-moving industries is the main motivation behind skill improvement training. When the National Joint Pipefitter Apprenticeship Committee on March 30, 1960, increased the classroom training requirements. . . the committee cited new technological advances in its industry as the reason. Glass and plastic pipe installing, silver soldering in large pneumatic control devices, and inert-gas shielded arc welding are examples of this new technology, and the plumber and pipefitter journeymen need to train for such operations as much as the apprentices. Similarly, the I.B.E.W. (International Brotherhood of Electrical Workers) maintains that the 'heart of automation' lies in the electrical industry, and its officers realize that journeymen training must reach a level at which

it can keep the craftsmen familiar with the new and changing working methods in cable splicing, welding, and electronics.[44]

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[44] Department of Labor, Monthly Labor Review, "Retraining the Unemployed, Part III, Skill Improvement training For Electricians and Plumbers", October 1963, p. 1075.

SECTION VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY AND CONCLUSIONS

It has been the purpose of this paper to investigate the present status of formalized training facilities maintenance craftsmen in the Navy; further, to determine if a problem exists or can be expected to develop in the future.

The approach to the problem was to conduct a questionnaire survey of Naval activities in the continental United States and compare the data received with current comparable data of non-government industry using the same skills. This was accomplished by reviewing the literature, correspondence, and personal interviews.

Section III established that the maintenance condition of the Shore Establishment is deteriorating as indicated by the large and increasing backlog of essential maintenance. It was shown that this backlog was due to insufficient maintenance funds in relation to the size, age and composition of facilities. Significant management improvements have been devised and implemented which have somewhat arrested the spiraling rise in the quantity of deferred maintenance work. These improvements have consisted primarily of management techniques and/or programs combined with consolidation of work forces into larger organizations. In the last decade, these management controls have increased efficiency 34% but recently have stayed level. This improvement represents about the maximum increase in productivity that can be expected unless more modern work methods and

more productive, better trained journeymen are employed.

Section IV developed a historical analysis of apprenticeship from the Code of Hammurabi, the oldest surviving code of laws, to the codification of the National Apprenticeship Act of 1937. From antiquity, through the Elizabethan eras, onward through the Colonial American period and beyond the Industrial Revolution, the social framework of apprenticeship was reshaped to fit the society. But the essence of apprenticeship did not change - the master craftsman, like the medical doctor, developed knowledge and skill through years of serious study and internship. It is the accumulation of knowledge acquired through hard study that separates the journeyman from the semi-skilled. Of primary importance in this historical analysis was the attempt to show that a society's or nation's interest in the formal training of craftsmen has a tendency to reappear through the ages. It does so at those moments in history when technological break-throughs or socialogical needs of a nation require ever increaseing skills and find that they are being plied by ever decreasing numbers of apprentice trained craftsmen. Such a time exists at the present.

Section V described the objectives, basic considerations and organization format used in developing an apprenticeship program in the Navy today. Methods of selecting apprentices and types of training, shop and related, are outlined as is the in-training promotion policy. Where the program is in operation it works well, except that no special recognition with respect to job protection or pay

is given the formally trained journeyman versus the journeyman with just general experience. Consequently, other than personal satisfaction in knowing how to perform at a higher quantity and quality level, there is little incentive to devote four years to hard study.

Section VI provides a comparative analysis of the current status of Naval facilities maintenance personnel to their contemporaries in private industry. The conclusions drawn from those findings are:

1. The problem of age - The Navy, through its hiring and reduction in force practices, has shaped a work force composed of old and middle aged journeymen. The seniority system has retained the older workers and has discouraged new hires, with the result that the Navy has 54% more personnel over 45 years of age than private industry in comparable journeymen categories. Of the 13,000 journeymen included in the survey, 83.4% were over 40 years old while only 1.4% were under 30 years of age.

2. The problem of Attrition - The loss rate of journeymen in the next 5 fiscal years (1965-1969), due to all causes, will be 264% higher than the national average for private industry in comparable journeymen categories. This constitutes 47% of the present work force. From inspection of the age distributions, it would appear that the problem will become even more acute after 1969.

3. The problem of recruitment - At present, only 10.7% of the journeymen are Navy apprentice trained. Almost 60%

are hired from the labor market where apprentice programs are currently projected to produce only 10% of the craftsmen required by the nation by 1970. It appears that those organizations that do not train their own personnel will go without in the very near future. In addition, the Navy can expect increasing criticism from private industry if they continue to let others bear the burden of paying for the training of craftsmen who are then hired by the Navy.

4. The problem of sub specialization - Many activities are subdividing crafts into semi-skilled jobs that can be learned without formal training. This, of course, requires more personnel and more supervision and results in a substantial decrease in productivity and flexibility at the very time when the opposite is desired. Due to the shortage of trained journeymen, this trend has been noted in private industry and an attempt to reverse the situation is being made.

5. The problem of training availability - The smaller an activity in the Navy the less likely it is to have an apprentice program. The opposite is true in private industry. The difference is that small companies and unions are assisted locally by government apprenticeship organizations to develop an apprentice program by grouping together and sharing costs. Navy activities, for reasons unknown to the writers, are not allowed to join such programs. Therefore, only very large activities can support such a program and even these are at a disadvantage in that no specific funds or personnel ceilings are provided. This

has had the bizarre effect at some air stations and shipyards of public works departments not participating in their own activity's apprenticeship program - even though in need of the trained journeymen.

The effort to update skills of journeymen at Naval Activities appears to vary widely. Those that are doing so are using several approaches which range from encouraging personnel to attend local trade school night courses to sending employees to industry schools (i.e. General Motors automotive mechanic schools, York Institute for air conditioning and refrigeration, etc.). Also, updating is accomplished by activity training, correspondence courses and in conjunction with other activities. Unfortunately, due to lack of guidance and non-recognition of the need, the majority of activities are doing nothing in this problem area.

II. RECOMMENDATIONS

The following recommendations, based on the data, findings and conclusions reached in this study, are believed to be necessary if the Navy is to adequately maintain the Shore Establishment at a reasonable cost in the future.

1. Further consolidation of Public Works Departments into larger units should be encouraged. The expected decrease in total numbers of journeymen as a result will help alleviate the coming attrition crisis due to a skewed age distribution. Also, larger organizations are more suited to supporting apprentice training programs "in house".

2. The Bureau of Yards and Docks should actively support updating of skills. What training is available, and where, must be made known. The District Public Works organizations could develop and promulgate such information to activities and their own contract inspection personnel, who in some cases have an even greater need to update their knowledge of modern construction techniques. The cost of this recommendation is minor and the potential is substantial.

3. Where consolidation of Public Works organizations is not feasible, activities should be permitted to participate with local industry and apprentice councils in training apprentices. Much assistance is available at the local level if activities were permitted and encouraged to use it.

4. Special funding and personnel allowance must be made available to activities. It is illogical to expect local Cammanding Officers, who serve at an activity for 2 or 3 years, to use substantial maintenance funds and personnel allowance for the development of an apprentice program. Even those who are concerned are often not aware of the rapidly disappearing supply of journeymen from the labor market.

5. A distinction should be made between the true journeyman - "one who has served an apprenticeship in a trade or craft," and the individual with general experience. The distinction should be by job classification and pay scale.

6. Journeymen classification should be rigidly controlled to prevent them being subdivided into semi-skilled jobs. Where subdivision is practical, they should be recognized as semi-skills, and not journeymen classifications.

7. Above all, it is essential to begin now to develop an input of trained craftsmen to off-set the anticipated loss of almost half the journeymen now employed in the next five years. This is no small order. It will require funds, personnel and technical direction. This direction should come from the Bureau of Yards and Docks, who is at present being judged on the performance of these journeymen. On 14 February of this year, the Chief of BUDOCKS stated, "After all, in the end, our effort should be directed toward supporting the man with the tools, the many people in the far flung shore activities of the Navy. The results of our stewardship in the facilities management field are going to be judged by the blue collar worker that they come in contact with. So keep in mind this objective in conducting your own program. Increase the productivity of the blue collar worker, the man with the tools." It is hoped that this study will help that objective come true.

BIBLIOGRAPHY

A. BOOKS

1. 1. Bergevin, Paul Emile. *Industrial Apprenticeship*. New York and London: McGraw-Hill Book Co., 1947.

2. Mays, Arthur B. *Essentials of Industrial Education*. New York: McGraw-Hill Book Company, Inc., 1952.

3. _____. *Principles and Practices of Vocational Education*. First Ed. New York: McGraw-Hill Company Inc., 1948.

4. _____. *The Problem of Industrial Education*. New York: The Century Co., 1927.

5. Miller, Elmo, and Jerome W. Blood (ed.). *Modern Maintenance Management*. American Management Association Inc. N. Y. 1963.

6. Monroe, Paul. *A Textbook in the History of Education*. New York: The MacMillan Company, 1949.

7. Patterson, William F. and M. H. Hedges. *Educating for Industry*. New York: Prentice-Hall, Inc., 1946.

B. PUBLICATIONS OF THE GOVERNMENT, LEARNED SOCIETIES AND OTHER ORGANIZATIONS

1. Bureau of Labor Statistics. *Industrial Retraining Progress for Technological* change. 1368, of 1963.

2. Department of the Navy. "Training of Apprentices", *Navy Civilian Personnel* Instruction 410, Section 10. 30 January 1962.

3. Department of the Navy. "Facilities Management Study", *Review of Management of the Department of the Navy*. Vol. 11, Study 6. Washington: Government Printing Office, 1962.

4. Department of the Navy. Bureau of Yards and Docks. *Civil Engineer Corps Directory*, NAVDOCKS-P-1, May, 1963. Washington: Government printing Office, 1963.

5. _____. Bureau of Yards and Docks. *Maintenance Management of Public Works and Public Utilities*, P-231, 1959. Washington: Government Printing Office.

6. _____. Bureau of Yards and Docks. *Organization and Functions for Public Works Departments*, NAVDOCKS P-318, November 1960. Washington: Government Printing Office.

7. _____. Bureau of Yards and Docks. *Work Improvements for Maintenance of Public Works and Public Utilities*, Vol. 1, Introduction and Lesson Plans, NAVDOCKS P-324, Oct. 1960. Washington: Government Printing Office, 1960.

8. _____. Bureau of Yards and Docks. *Work Improvements for Maintenance of Public Works and Public Utilities*, Vol. 11, Procedures and Uses, NAVDOCKS P-324, Oct. 1960. Washington: Government Printing Office, 1960.

9. _____. Secretary of Defense. DOD Directive 4165.9 of 23 June 1955. Subj: Programs for Management of Real Property Maintenance Activities.

10. _____. Secretary of the Navy. SECNAV Instruction 11011.5 of 21 Oct. 1954. Subj: Objectives and Policies Relating to Real Property Maintenance and Utilities Operation Program.

11. _____. Secretary of the Navy. SECNAV Instruction 11014.3 of 29 June 1955. Subj: Programs for Management of Real Property Maintenance Activities.

12. _____. Secretary of the Navy. SECNAV Instruction 11014.7 of 21 February 1958. Subj: Maintenance Management of Public Works and Public Utilities.

13. Hanna, Charles F. *Employment and Manpower*. Statement before United States Senate Subcommittee on Employment and Manpower. October 18, 1963.

14. National Association of Manufacturers. *Your Opportunities in Industry as a Skilled Craftsman.* New York: Educational Dept. February 1957.

15. New York State Department of Labor Apprenticeship Council. *Apprenticeship in New York State*. 1948.

16. State of California. Division of Apprenticeship Standards. *A Study and Comparison of California Apprenticeship Completions and Journeymen Losses with National Completions and Losses*. Mimeographed material. 1958.

17. _____. Department of Industrial Relations, Division of Apprenticeship Standards. *A Survey of Apprenticeship in Metal Trades, in Manufacturing and Aircraft Industry*. California State Printing Office, 1959.

18. _____. Department of Industrial Relations. Division of Apprenticeship Standards. *Craftsmanship Through Apprenticeship*. California State Printing Office, 1960.

19 _____. Department of Industrial Relations. *California Conference on Apprenticeship*, April 1962. Mimeographed Material.

20. _____. Division of Apprenticeship Standards. *Survey of Completed Apprentices*. California State Printing Office, 1962.

21. The 42 Northern California Counties Carpenters. Joint Apprenticeship and Training Committees. *A Handbook For Carpenter Apprentices*. 1963 - 1964 Edition. Santa Rosa, California

22. United States Civil Service Commission. *Assessing and Reporting Training Needs and Progress*. Personnel Methods Series No. 3, June 1956. Washington: Government Printing Office, 1957.

23. United States Congress, Public Law 87-415, *Manpower Requirements, Developments and Utilization*. 87th Congress, S.1991, March 15, 1962.

24. United States Department of Labor. Bureau of Labor Statistics in Cooperation with Veterans Administration. *Employment Outlook For Sheet Metal Workers, Roofers.* Bulletin No. 1255-79. Washington: Government Printing Office, 1960.

25. _____. *Manpower Challenge of the 1960s*. Washington: Government Printing Office, 1960.

26. _____. Bureau of Apprenticeship and Training. *A Look at Industrial Training in Mercer Country, New Jersey*, September 1959. Washington: Government Printing Office, 1959.

27. _____. Bureau of Apprenticeship and Training. *Career Patterns of Former Apprentices*. Bulletin 1-147, Mar. 1959. Washington: Government Printing Office , 1959.

28. _____. Bureau of Apprenticeship and Training. *Manpower Development and Training Act. - Allowable Costs on the Job Training Facilities*. Circular Letter 63-97.

29. _____. Bureau of Apprenticeship and Training. *Research on Skill Development in Industry*, October 1957. Washington: Government Printing Office.

30. _____. Bureau of Labor Statistics in Cooperation with Veterans Administration. *Employment Outlook for Painters, Paperhangers, Glaziers, Asbestos and Insulating Workers*. Bulletin No. 1255-54 Washington: Government Printing Office, 1960.

31. _____. Bureau of Labor Statistics in Cooperation with Veterans Administration. *Employment Outlook for Plasterers, Lathers, Cement Finishers*. Bulletin No. 1255-63. Washington: Government Printing Office, 1960.

32. _____. Bureau of Labor Statistics in Cooperation with Veterans Administration. *Employment Outlook in the Machinists, Tool and Die Makers, Instrument Makers, Other Machining Occupations*. Bulletin No. 1255-44. Washington: Government Printing Office, 1960.

C. PERIODICALS

1. "Apprentice Contest and Instructor Training Course," Heating - Piping, 32: 39-40, October, 1960.

2. "Apprentices Are Hard to Get." Engineering News Record, 166:81, June, 1961.

3. "Apprentices Are Still Short," Business Week, August 15, 1953, p. 46.

4. "Apprentice Training Programs," Air Conditioning and Refrigeration News, 84: 6-7, June 2, 1958.

5. "Apprenticeship Systems Held Vital," Railway Age, 145: 32-3, Aug. 4, 1958

6. "Are You Training Enough Apprentices?", Engineering News-Record, 168: 289, June 21, 1962

7. "Big Fund Helps Apprenticeship," Engineering News-Record, 166:126, March 9, 1961.

8. Bish, John. "A Toolroom Foreman Talks Training," Supervisory Management, 6:51-2, May, 1961.

9. Breslaw, G. "Use Apprentices More, or Lose Them to Other Trades," Domestic Engineering, 197:14, February 1961.

10. "Bricklayers Urge More Training," Engineering News-Record, 162:191, May 14, 1959.

11. "California's Statewide Contest Provides a Yardstick for Apprentice Skills," American Machinist Metalworking Manufacturing, 104:111-14, February 8, 1960.

12. "Carpenters Face Shortage of Journeymen," Engineering News-Record, 169:74, December 13, 1962.

13. Christensen, W. C. "I T U Meets New Technologies Head-On," Graphic Art Monthly, 32:34-6, October 1960.

14. "Contractors Promote Education," Engineering News-Record, 168:81 February 22, 1962.

15. "Council Officers Program to Train More Apprentices," Air Conditioning, Heat and Refrigeration News, 95:1+, Feb. 5, 1962.

16. Csaszar, E. J. "Moldmaking and Tooling; Moldmaker Apprenticeship Training," Plastics Technology, 4:61, January, 1958.

17. Davis, Rennard. "Retraining the Unemployed, III -Skill Improvement Training for Electricians and Plumbers," Monthly Labor Review, October, 1961, pp. 1074-1080.

18. "Deming Picks Key Men From Apprentice Training Graduates," *Plant*, 19:62-3, May, 1959.

19. Drew, A. S. "Related Science For Apprentices," *Industrial Arts and Vocational Education*, 42:152-4, May 1953.

20. Engler, B. "We Train our Own," *Factory*, 119:70-1, Feb. 1961.

21. "E M S A Sponsers Apprenticeship Training Program,: *Diesel Power*, 38:26, October 26, 1960.

22. Favel, W. "He Worked to Learn," Scholastic, 65:32-3, September 15, 1954.

23. Feisthorn, C. H. "Analytical Results of a Carpenter Apprentice Program," *Industrial Arts and Vocational Education*, 43:192-3, June 1954.

24. Fleming, A. E. "How Detroit Trains Apprentices," *Iron Age*, 185:62, May 26, 1960.

25. "Five Years Later; 92% of All Graduate California Apprentices Found Still at Same Trade," *Air Conditioning and Refrigeration News*, 83:1, March 3, 1958.

26. Goshen, Edward E. "Is There a Skilled Labor Shortage," *Steele*, 151:25-6, Aug. 27, 1962.

27. Groom, Phyllis P. "Retraining the Unemployed, I - European Government Programs," *Monthly Labor Review*, Aug. 1961. pp.823-828.

28. _____. "Retraining the Unemployed, IV - The Bridgeport Program," *Monthly Labor Review*, January, 1962, pp. 24-29.

29. _____ "Retraining the Unemployed II - Federal and State Legislation on Retraining," *Monthly Labor Review*, Sept. 1961,pp.939-943.

30. Hagemeyer, Richard H. "Apprentice Selection Practices," *Personnel Journal*, 41:135-7, March 1962, pp. 135-137.

31. Hankin, E. K. "Our Critical Craftsman Shortage," *Industrial Arts and Vocational Education*, 49: 18-19, November 1960.

32. Hyman, I. H. "Toolroom Foreman Talks Training," *American Machinist Metalworking Manufacturing*, 105:80-2, February 6, 1961.

33. "I. C. I. Billingham Engineering Apprentice School," *Chemistry and Industry*, January 4, 1958, p. 7.

34. "Industry's Future Tied to Apprenticeship," *Engineering News-Record*, 159:79, December 26, 1957.

35. "International Apprenticeship Competition," Monthly Labor Review, 78:917, August, 1955.

36. "International Training Fund Has Awarded Grants of More Than $1,820,000 in Three Years," Air Conditioning, Heat and Refrigeration, 91:23, October 24, 1960.

37. "International Union of Operating Engineers Turns to Formal Apprenticeship," Engineering News-Record, 169:77-8, July 26, 1962.

38. "Labor Department Report on Number of Men in Training for Trades," Air Conditioning, Heat and Refrigeration, 86:11, Apr. 20, 1959.

39. McCauley, John S. "Employment Status of Former Apprentices in Early 1954," Monthly Labor Review, 77:751-5.

40. "Mechanic Shortage," Air Conditioning, Heat and Refrigeration News. 96:1, August 27, 1962.

41. Mitchell, James P. "T V A Apprenticeship Program," Power, 104:199-201, November, 1960.

42. Moore, B. V. "Commercial Apprenticeship at Phillips Electric Ltd.," Personnel Management, 43: 110-19, June, 1961.

43. Motley, Arthur W. "Recent Trends in Test Selection of Apprentices," Monthly Labor Review, 76: 1065-70, October, 1963.

44. "M T B A Apprentice Plan Stresses Merit, Not Mere Timeserving," American Machinist Metalworking Manufacturing, 106:106-7, December 10, 1962.

45. "National Association of Plumbing Contractors Panel Emphasized Need for Careful Selection of Apprentices," Air Conditioning, Heat and Refrigeration, 90:5, August 8, 1960.

46. "Our Apprentice Setup Is a Scandal," American Machinist, 103:124-6, September 21, 1959.

47. Owen, B. "Training Industrial Electricians," Plant Engineer, 16:113-15, August 1962.

48. Parker, J. A. "Modern Trends in Industrial Arts Vocational Education," Industrial Art and Vocational Education, 43:200, June, 1954.

49. Patterson, W. F. "Importance of Related Instruction to Apprenticeship," Industrial Art and Vocational Education, 43:66A March 1954.

50. _____. "Selecting the Best Qualified for Carpentry Apprenticeship," Industrial Art and Vocational Education, 46:103-3, March 1957.

51. Peterson, J. L. "Training Maintenance Apprentices and Supervisors," Tool Engineering, 44: 331-3, April 1960.

52. "Progress Report of Armour's Tripartite Automotive Committee," *Monthly Labor Review*, August 1961, pp. 851-857.

53. Ruthenburg, Louis. "The Crisis in Apprentice Training," *Personnel* 36: 28-33, July 1959.

54. Schuster, J. H. "Career Patterns of Former Apprentices in the Construction Trades," *Construction Review*, 5:4-7, May 1959.

55. "School, Sponsered Jointly by R A C C A and Union," *Air Conditioning, Heat and Refrigeration*, 95:7102, February 12, 1962.

56. "Report on Apprenticeship," Supervision, 25:25, March 1963.

57. "Techicians: A New Concern," *Engineering News-Record,* 162:300, June 18, 1959.

58. "Thirty Become Journeymen in CAlifornia On-the-Job and Classroom Program," *Air Conditioning, Heat and Refrigeration*, 91:7, October 24, 1960.

59. "To Promote Training," *Engineering News Record*, 163:81, Aug.27,1959.

60. "Training: A Doomed Crusade?" *Engineering News-Record*. 162:102, March 26, 1959.

61. "Training For Commerce," *Personnel Management*, 41:130-2, Sept. 1959.

62. "Trends in the Development of Apprentice-Training Programs," *Monthly Labor Review*, 78:564, May, 1955.

63. "U. A. Instructors Embark on a Five-Year Plan for Pipefitter Apprentice Instructors," *Heating and Piping*, 31:91-3, Sept. 1959.

64. Wecksler, A. N. "Worker Training-Industry Does it Better," *Mill and Factory*, 73:84-7, September 1963.

65. "Weighing Apprenticeship in the Balance," *American Machinist Metalworking Manufacturing*, June 13, 1960.

66. Weinberg, Edgar. "Retraining Older Workers," *Monthly Labor Review,* August 1963, pp. 935-939.

67. "West German Apprentice System; Key to Precision Products," *Modern* Photography, 22:sup W25 + December 1958.

68. Williams, W. T. "Apprentice Plant Engineers Add Experience to Education," *Plant Engineering*, 17:114-16, September 1963.

APPENDIX A

LIST OF ACTIVITIES THAT PARTICIPATED IN THE SURVEY BY GROUP AND SIZE

Activities in Group Nr. 1

Activity Nor.	Title and Location
1	U. S. Naval Personnel Center 30th Fort Streets, Omaha, Nebraska
2	U. S. Naval Supply Depot Great Lakes, Illinois
3	U. S. Naval Ordnance Missile Test Facility White Sands Missile Range, New Mexico
4	U. S. Naval Training Center Port Washington, New York
5	U. S. Naval Supply Corps School Athens, Georgia
6	U. S. Naval Security Group Activity Winter Harbor, Maine
7	U. S. Naval Communications Station, Norfolk Norfolk, Virginia
8	U. S. Naval Auxiliary Air Station New Iberia, Louisiana
9	U. S. Naval Air Station Los Alamitas, California
10	U. S. Naval Hospital Beufort, South Carolina
11	U. S. Naval Air Station New Orleans, Louisiana
12	U. S. Naval Ammunition Depot Hastings, Nebraska
13	U. S. Naval Supply Center Oakland, Stockton Annex Stockton, California
14	U. S. Naval Air Station Willow Grove, Pennsylvania
15	U. S. Naval Station Boston, Massachusetts

Group Nr. 1 (cont'd)

16 U. S. Naval Air Facility
Litchfield Park, Phoenix, Arizona

17 U. S. Naval Radio Station (T)
Cutler, East Machias, Maine

18 U. S. Naval Turbine Test Station
Trenton, New Jersey

19 U. S. Naval Ammunition Depot
St. Juliens Creek, Portsmouth, Virginia

20 U. S. Naval Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

21 David Taylor Model Basin
Washington, D. C. 7

22 U. S. Marine Corps Air Facility
New River, Jacksonville, North Carolina

23 U. S. Naval Ordnance Plant
Macon, Georgia

24 U. S. Naval Hospital
Philadelphia, Pennsylvania

25 U. S. Naval Communications Station
Navy Nr. (85), FPO San Francisco, Calif.

Activities in Group Nr. 2

Activity Nr.	Location and Title
26	U. S. Naval Security Station 3801 Nebraska Ave., NW, Washington D.C.
27	U. S. Marine Corps Air Facility Santa Ana, California
28	U. S. Naval Auxiliary Air Station Van Voorhis Field, Fallon, Nevada
29	U. S. Naval Air Station Glenview, Illinois
30	U. S. Naval Air Station Grosse Isle, Michigan
31	U. S. Naval Ammunition Depot Earle, Red Bank, New Jersey
32	U. S. Naval Air Station Cecil Field, Florida
33	U. S. Naval Air Station Sanford, Florida
34	U. S. Naval Hospital Camp Pendleton, California
35	U. S. Naval Air Station New York, Brooklyn, New York
36	Defense Atomic Support Agency Lake Mead Base, Las Vegas, Nevada
37	U. S. Naval Air Station Lakehurst, New Jersey
38	U. S. Naval Air Station Seattle, Washington
39	U. S. Naval Hospital Great Lakes, Illinois
40	U. S. Naval Ordnance Plant Forest Park, Illinois

Group Nr. 2 (cont'd)

41 U. S. Naval Auxiliary Air Station

42 U. S. Naval Air Development Center
Johnsonville, Pennsylvania

43 U. S. Naval Supply Depot
Mechanicsburg, Pennsylvania

44 U. S. Naval Training Center
Bainbridge, Maryland

45 U. S. Naval Hospital
Oakland, California

46 U. S. Marine Corps Air Station
Navy Nr. 990, San Francisco, California

47 U. S. Naval Mine Defense Laboratory
Panama City, Florida

48 U. S. Naval Air Station
Key West, Florida

49 U. S. Naval Ammunition Depot
Charleston, South Carolina

50 U. S. Naval Shipyard
San Francisco, California

Activities in Group Nr. 3

Activity Nr.	Title and Location
51	U. S. Naval Supply Depot Seattle 99, Washington
52	National Naval Medical Center Bethesda, Maryland
53	U. S. Naval Supply Center-Navy Base Annex Bayonne, New Jersey
54	U. S. Naval Air Station Whidby Island, Oak Harbor, Washington
55	U. S. Naval Weapons Station Concord, California
56	U. S. Marine Corps Supply Center Albany, Georgia
57	U. S. Naval Hospital Portsmouth, Virginia
58	U. S. Naval Ordnance Plant Iroquois Station, Louisville 14, Kentucky
59	U. S. Naval Shipyard Charleston, South Carolina
60	U. S. Naval Air Station Lemoore, California
61	U. S. Naval Air Station Moffett Field, California
62	U. S. Naval Air Station Memphis 15, Tennessee
63	U. S. Naval Shipyard Long Beach 2, California
64	U. S. Naval Air Station Brunswick, Maine
65	U. S. Marine Corps Supply Center Barstow, California

Group Nr. 3 (cont'd)

66 U. S. Naval Air Station
Barbers Point, Hawaii

67 U. S. Marine Corps Supply Center
Barstow, California

68 U. S. Naval Ammunition Depot
Bremerton, Washington

69 U. S. Naval Shipyard
Philadelphia 12, Pennsylvania

70 U. S. Naval Station
Long Beach, California

71 U. S. Naval Marine Engineering Laboratory
Annapolis, Maryland

72 U. S. Naval Air Engineering Center
Philadelphia, Pennsylvania

73 U. S. Naval Ammunition Depot
Crane, Indiana

74 U. S. Naval Amphibious Base
Little Creek, Norfolk, Virginia

75 U. S. Naval Ammunition Depot
McAlester, Oklahoma

Activities in Group Nr. 4

Activity Nr.	Title and Location
76	U. S. Marine Corps Air Station Cherry Point, North Carolina
77	U. S. Navy Public Works Center Newport, Rhode Island
78	U. S. Naval Construction Battalion Center Port Hueneme, California
79	U. S. Naval Ammunition Depot Hawthorne, Nevada
80	U. S. Naval Station Treasure Island, California
81	U. S. Marine Corps Air Station El Toro, Santa Ana, California
82	U. S. Naval Station Key West, Florida
83	U. S. Naval Propellant Plant Indian Head, Maryland
84	U. S. Naval Air Station Quonset Point, Rhode Island
85	U. S. Naval Air Station North Island, San Diego, California
86	U. S. Naval Supply Center Oakland, California
87	U. S. Naval Academy Annapolis, Maryland
88	U. S. Naval Training Center Great Lakes, Illinois
89	U. S. Naval Air Station Jacksonville, Florida
90	U. S. Naval Station Washington 25, D.C.

Group Nr. 4 (cont'd)

91 U. S. Marine Corps Base
Camp Pendleton, California

92 U. S. Naval Air Station
Patuxent River, Maryland

93 U. S. Naval Shipyard
Bremerton, Washington

94 U. S. Navy Public Works Center
Navy Nr. 128, FPO San Francisco, Calif.

95 U. S. Naval Shipyard
Portsmouth, Virginia

96 U. S. Naval Air Station
Alameda, California

97 U. S. Naval Shipyard
Vallejo, California

98 U. S. Naval Shipyard
Brooklyn, New York

99 U. S. Naval Ordnance Test Station
China Lake, California

100 U. S. Navy Public Works Center
Norfolk, Virginia

Activities Whose Public Works Functions Have Been Transferred To Another Activity

Activity Nr.	Title and Location
101	U. S. Naval Torpedo Station Keyport, Washington
102	U. S. Naval Auxiliary Air Station Saufley Field, Pensacola, Florida
103	U. S. Naval Auxiliary Air Station Imperial Beach 33, California
104	U. S. Naval Training Center San Diego 33, California
105	U. S. Naval Supply Center San Diego, California
106	U. S. Naval Hospital San Diego 34, California

Activities With No Civilian Employment

Activity Nr.	Title and Location
107	U. S. Naval Facility Nantucket, Massachusetts
108	U. S. Naval Facility Lewis, Delaware
109	U. S. Naval Facility Cape Hatteras, Buxton, North Carolina
110	U. S. Naval Facility Coos Head, Empire, Oregon
111	U. S. Naval Auxiliary Landing Field Bonham, Navy Nr. 14, FPO San Francisco, Calif.
112	U. S. Naval Station - Navy Yard Annex Washington, D.C.

Activities Not Desiring to Participate in the Survey

Activity Nr.	Title and Location
113	U. S. Naval Public Works Center San Diego 36, California
114	U. S. Naval Air Station Oceana, Virginia Beach, Virginia
115	U. S. Marine Corps Recruit Depot Parris Island, South Carolina
116	U. S. Marine Corps Base Camp LeJeune, North Carolina
117	U. S. Naval Air Station South Weymouth Massachusetts

APPENDIX B

QUESTIONNAIRE DATA IN TABULATED FORMAT

AGE DISTRIBUTION

GROUP NR. 1

Age Groups Activity	Total	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60 +
1	10				1	3	3		3	
2	12				1	2	3	3	3	
3	16			2	3	3	4	2	2	
4	16				3	4	2	5	1	1
5	16				1	3	2	3	1	1
6	16				4	2	6	3		1
7	18				1	2	6	4	2	3
8	22			3	1	5	8	2	2	1
9	23					3	8	2	6	4
10	24			6	2	12	3	1		
11	24				6	6	6	3		3
12	26			2	2	5	6	2	6	3
13	27					1	7	7	4	8
14	28				1	3	3	7	10	4
15	29			2	1	3	6	3	6	8
16	30				5	2	11	3	6	3
17	30			5	6	9	5	1	1	3
18	31				3	5	7	8	4	4
19	32	1		3	1	7	8	5	5	2
20	34				3	3	11	8	2	7
21	35			2	5	9	7	7	4	1
22	36		1	2	9	7	6	6	3	2
23	37			2	3	4	6	4	11	7
24	37			1	7	3	11	6	3	6
25	37		2	3	7	15	3	2	4	1
Total	646	1	3	33	76	126	148	97	89	73
Per cent	100%	0.2%	0.5%	5.1%	11.8%	19.5%	22.9%	15.0%	13.8%	11.2%

AGE DISTRIBUTION

GROUP Nr. 2

Age Groups / Activity	Total	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60 +
26	37	1		6	7	1	9	3	4	6
27	39		1	1	3	9	8	4	7	6
28	40	1		4	7	4	7	4	10	3
29	42	1	2	3	3	5	9	7	4	8
30	42			1	5	10	11	5	6	4
31	42			2	8	3	14	5	4	6
32	43				8	10	4	7	9	5
33	46			1	5	7	10	9	7	7
34	49			4	1	13	11	4	8	8
35	50		4	5	13	10	12	4	2	
36	54			7	3	12	10	9	7	6
37	55			5	8	7	13	13	7	2
38	55		1	3	1	6	13	10	11	10
39	57	2	4	7	14	10	8	8	4	
40	58		1	2	8	14	9	8	8	
41	60				5	12	13	14	10	6
42	64		3	1	1	12	9	12	10	16
43	68		1	1	8	16	21	7	8	6
44	74			2	18	18	16	8	5	7
45	76		2	1	7	15	20	8	14	9
46	79			3	12	23	29	6	4	2
47	82		2	2	16	33	13	10	4	2
48	90		2	10	10	27	15	10	9	7
49	92		2	12	6	24	23	13	6	6
50	95			2	5	16	19	18	18	17
Total	1489	5	25	85	182	317	326	206	186	157
Per cent	100%	0.3%	1.7%	5.7%	12.2%	21.3%	21.9%	13.8%	12.5%	10.6%

AGE DISTRIBUTION

GROUP NR. 3

Age Groups / Activity	Total	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60 ⁄
51	97		1		3	22	24	19	10	18
52	99		2	3	11	20	27	12	15	9
53	100			1	7	22	35	11	11	9
54	101				8	23	18	14	21	17
55	104		1	3	3	25	15	23	19	15
56	106	1	3	9	19	24	22	5	13	10
57	111			7	14	20	19	23	17	11
58	112		1	1	27	27	24	11	16	5
59	116	1	3	4	10	24	29	18	18	9
60	118	2	3	12	24	24	29	3	18	3
61	121	2		5	24	33	26	18	13	
62	121			3	15	26	23	16	19	19
63	125		1	4	6	15	22	23	24	30
64	133			3	14	30	27	19	16	24
65	134	1	4	10	15	23	22	29	19	11
66	144		1	9	22	30	36	11	22	13
67	152	5	6	10	11	24	28	19	32	17
68	154			14	15	25	35	17	37	11
69	156	1	1	5	7	24	30	27	27	34
70	159		1	6	12	28	29	20	23	40
71	165		2	2	13	45	45	19	22	17
72	166		1	11	10	27	18	41	27	31
73	172		1	5	31	42	37	21	24	11
74	181			18	34	35	44	10	36	4
75	189	1	6	5	38	57	35	11	24	12
Total	3336	14	38	150	393	695	699	434	533	380
Per cent	100%	0.4%	1.1%	4.4%	11.5%	20.8%	20.9%	15.9%	13.1%	11.9%

[illegible]

[illegible]

AGE DISTRIBUTION

GROUP NR. 4

Age Groups Activity	Total	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60 +
76	195		1	12	26	32	40	40	27	17
77	197		1	5	5	42	34	47	35	28
78	198			6	21	39	43	31	33	25
79	199	1	6	20	23	35	31	26	27	30
80	207		7	4	15	31	50	34	24	42
81	209			2	25	40	39	34	38	31
82	209		4	15	20	42	41	31	26	30
83	209	1	5	16	41	49	51	27	11	8
84	212			7	34	44	47	28	26	26
85	232	2	2	9	18	40	53	42	33	33
86	234		1	6	5	44	69	39	36	34
87	250			9	37	48	48	37	46	25
88	250			11	25	43	52	46	32	41
89	264		7	24	32	34	61	47	35	24
90	278	1	4	13	26	58	44	61	33	37
91	329	1	3	17	33	68	70	59	43	43
92	338			21	33	75	61	71	44	37
93	365		5	30	41	50	61	77	60	50
94	409	2	8	10	69	124	102	39	13	22
95	425		2	7	40	66	83	103	73	48
96	443	4	4	12	29	86	108	75	60	70
97	444	1	3	4	40	71	91	83	86	57
98	490			24	29	128	112	120	23	74
99	513	5	8	18	55	86	93	85	65	92
100	705	1	7	21	60	153	187	116	91	72
Total	7804	19	78	315	782	1524	1671	1398	1021	996
Percent	100%	0.2%	1.0%	4.1%	10.0%	19.5%	21.4%	17.9%	13.1%	12.8%

ANTICIPATED LOSSES

GROUP NR. 1

Activity Nr.	FY 65	FY 66	FY 67	FY 68	FY 69	5 Year Total	Total Journeymn	Losses as % of Journeymn	Variance of % Losses σ^2
1	2	2	2			6	10	60.0	635.04
2					1	1	12	8.3	812.25
3					2	2	16	12.5	497.29
4			4	1		5	16	31.2	12.96
5	1	1	2	1	1	6	16	37.5	7.29
6		1				1	16	6.2	817.96
7	1	1	1	2	1	6	18	33.3	2.25
8	1	1	1	1	1	5	22	22.7	146.41
9	1	1	1	1	1	5	23	21.8	169.00
10	1	1	2	2	2	8	24	33.3	2.25
11				1	2	3	24	8.0	718.24
12 *	12	13	1			26	26	100.0	4251.04
13	3	3	2	2	2	12	27	44.5	94.09
14	1	2	2	1	3	9	28	32.2	6.76
15	3	2	3	2	2	12	29	41.4	43.56
16	3	2	1	1	3	10	30	33.3	2.25
17		1	1	2	2	6	30	20.0	219.04
18	2	3	3	4	4	16	31	51.6	282.24
19	2	2	2	2	2	10	32	31.2	12.96
20	3	3	2	2	2	12	34	35.3	.25
21	2	3	2	4	2	13	35	37.2	5.76
22	4	5	5	6	7	27	36	75.0	1616.04
23	3	4	3	3	3	16	37	43.3	72.25
24	1	1	2	2	3	10	37	27.0	60.84
25	1	2	2	2	2	9	37	24.3	110.25
Total	47	54	44	43	48	236	646	871.1	10598.27
% of Total Employment	7.3%	8.4%	6.8%	6.7%	7.3%	36.5%	$\overline{X} = 34.8$	$\sigma^2 = 423.93$	$\sigma = 20.6$
% of Total Employed (corrected within 2σ)	5.6%	6.5%	6.9%	6.9%	7.7%	33.6%			

* This activity being phased out

ANTICIPATED LOSSES
GROUP NR. 2

Activity Nr.	FY 65	FY 66	FY 67	FY 68	FY 69	5 Year Total	Total Journeymn	Losses as % of Journeymn	Variance of % Losses σ^2
26	2	2	2	4	4	14	37	37.9	1.44
27	5	4		2	4	15	39	38.5	3.24
28	7	7	7	7	7	35	40	87.5	2580.64
29	3	1		2		7	42	16.7	400.00
30	2	2	2	2	1	8	42	19.1	309.76
31	2	2	2	2	2	10	42	23.8	166.41
32	2	1	2	1	2	8	43	18.6	327.61
33	3	5	5	6	7	26	46	56.5	392.04
34	4	4	4	4	4	20	49	40.8	16.81
35	3	5	4	3	5	20	50	40.0	10.89
36	3	3	3	3	3	15	54	27.8	79.21
37	4	5	7	8	9	33	55	60.0	542.89
38	6	6	6	6	6	30	55	54.5	316.84
39	1					1	57	6.8	1218.01
40	6	6	6	6	6	30	58	51.8	228.01
41	7	9	8	7	7	38	60	63.4	712.89
42	3	2	4	6	2	17	64	26.6	102.01
43	4	4	4	4	4	20	68	29.4	53.29
44	1	1	1	1	2	6	74	8.1	817.96
45	5	5	5	5	5	25	76	32.1	21.16
46	5	5	6	6	7	29	79	36.6	-
47	5	5	5	5	5	25	82	30.5	38.44
48	6	7	6	7	6	32	90	35.6	1.21
49	2	6	3	2	6	19	92	20.7	256.00
50	12	18	12	12	12	60	95	63.2	702.25
Total	103	109	102	113	116	543	1489	921.6	9299.01
% of Total Employed	6.9%	7.3%	6.9%	7.6%	7.8%	36.5%	$\bar{X} = 36.7$	$\sigma^2 = 371.96$	$\sigma = 19.3$
% of Total Employed (corrected) (within 2σ)	6.6%	7.0%	6.6%	7.3%	7.5%	35.0%			

ANTICIPATED LOSSES

GROUP NR. 3

Activity Nr.	FY 65	FY 66	FY 67	FY 68	FY 69	5 Year Total	Total Journeymn.	Losses as % of Journeymn	Variance of % Losses σ^2
51	14	14	14	14	14	10	97	72.2	372.49
52	9	10	11	12	12	54	99	54.6	2.89
53	15	10	11	10	10	56	100	56.0	9.61
54	8	10	10	12	12	52	101	51.5	1.96
55	6	7	8	10	11	42	104	40.4	156.26
56	4	6	8	10	15	43	106	40.6	151.29
57	2	2	2	2	2	10	111	9.0	1927.21
58	2	3	3	4	7	19	112	17.0	1288.81
59	11	11	12	12	12	58	116	50.0	8.41
60	22	22	22	22	22	110	118	93.2	1624.09
61	20	20	20	20	20	100	121	82.6	882.09
62	10	12	12	12	14	60	121	49.6	10.89
63	17	18	20	22	23	100	125	80.0	734.41
64	6	6	6	6	6	30	133	22.5	924.16
65	3	5	8	8	11	35	134	26.1	718.24
66	4	5	5	5	5	24	144	16.7	1310.44
67	35	35	32	30	30	162	152	100.0	2275.29
68	13	15	10	11	13	62	154	40.2	161.29
69	5	7	8	5	8	33	156	21.1	1011.24
70	23	24	20	26	21	114	159	71.7	353.44
71	20	28	30	30	36	144	165	87.3	1183.36
72	17	18	19	20	24	95	166	57.2	18.49
73	16	16	17	18	49	86	172	50.0	8.41
74	49	40	40	40	40	209	181	115.4	3906.25
75	6	7	6	6	6	31	189	16.4	1332.25
Total	337	351	354	367	390	1799	3336	1321.9	20373.26
% of Total Employed	10.1%	10.5%	10.6%	11.1 %	11.6%	53.9%	$\bar{X}$ =52.9	σ^2=814.93	σ = 28.5
% of Total Employed. (corrected within 2 σ)	9.1%	9.9%	10.0%	10.4%	11.1%	50.5%			

ANTICIPATED LOSSES

GROUP NR. 4

Activity Nr.	FY 65	FY 66	FY 67	FY 68	FY 69	5 Year Total	Total Journeymn	Losses as % of Journeymn	Variance of % Losses σ^2
76	12	12	12	12	12	60	195	30.8	712.89
77	20	19	18	19	20	96	197	48.7	77.44
78	48	50	53	55	58	264	198	133.2	5730.49
79	25	25	25	25	25	125	199	62.8	28.09
80	14	16	14	18	20	82	207	39.6	320.41
81	28	31	34	37	40	170	209	81.3	566.44
82	22	26	31	37	44	160	209	76.5	361.00
83	28	25	25	26	28	132	209	62.7	27.04
84	26	27	29	26	26	134	212	63.2	32.49
85	40	40	40	40	40	200	232	86.3	829.44
86	67	70	73	75	78	363	234	155.0	9506.25
87	24	24	22	23	22	115	250	46.0	132.25
88	17	17	17	17	17	85	250	34.0	552.25
89	7	6	5	8	10	36	264	13.6	1927.21
90	6	16	8	6	11	47	278	16.9	1648.36
91	32	32	32	32	32	160	329	48.7	77.44
92	36	40	44	48	51	219	338	64.8	53.29
93	39	21	10	12	10	92	365	25.2	1043.29
94	13	12	15	10	14	64	409	15.6	1755.61
95	41	49	45	52	54	241	425	56.7	.64
96	22	22	22	22	22	110	443	24.8	1069.29
97	85	85	85	85	85	425	444	95.7	1459.24
98	40	40	40	40	40	200	490	40.8	278.89
99	75	73	70			218	513	42.5	225.00
100	110	106	95	95	100	506	705	71.8	204.49
Total	877	884	864	820	859	4304	7804	1437.2	28629.23
% of Total Employed	11.2%	11.3%	11.1%	10.5%	11.1%	55.2%	$\bar{X}$ =57.5	σ^2=1145.2	σ = 33.8
% of Total Employed (corrected within 2σ)	10.3%	10.4%	10.0%	9.5%	9.8%	50.0%			

METHOD OF RECRUITMENT

Group Nr. 1

Activity Nr.	In House		Outside Hire		Total Journeymen
	Apprentice Program	Helper Program	Certified Journeymen	General Experience	
1		2	3	4	10
2		4	3	2	12
3		4	3	2	16
4		3.5	3.5		16
5		2	4	3	16
6			4		16
7		4	2	3	18
8		3.5		3.5	22
9		2	4	3	23
10		2	4	3	24
11		4	3	3.5	24
12		3.5		3	26
13		2	4	3	27
14			4		28
15			4	3	29
16		3	3	3.5	30
17		3.5			30
18		3.5	3.5	3	31
19		3	3	2	32
20		4	3	1	34
21	2	3	4	2	35
22		3	4	3.5	36
23			3.5	2	37
24		4	3	3	37
25		3	3	3	37
Weight	70	1911.5	1962.0	1500.5	5444
Weighted Percent	1.3%	35.1%	36.0%	27.6%	100%

METHOD OF RECRUITMENT

Group Nr. 2

Activity Nr.	In House		Outside Hire		Total Journeymen
	Apprentice Program	Helper Program	Certified Journeymen	General Experience	
26		2	4	3	37
27		3	3	3	39
28		3.5		3.5	40
29	4		3		42
30		4	3	2	42
31		4	3		42
32		4	3		43
33		3	4	2	46
34		3.5	3.5	3	49
35		3	3	4	50
36		3	3	3	54
37		3	3		55
38		3	3		55
39		3.5	3.5	4	57
40		3	3	3	58
41		4	4		60
42		3	3		64
43		3	3	3.5	68
44					74
45		4	4	4	76
46		3	3		79
47		4	4	2	82
48		4	4	4	90
49		3	3	2	92
50		4	4	4	95
Weight	169	3929	4664	2800	11561
Weighted Percent	1.5%	33.9%	40.3%	24.3%	100 %

METHOD OF RECRUITMENT

Group Nr. 3

Activity Nr.	In House		Outside Hire		Total Journeymen
	Apprentice Program	Helper Program	Certified Journeymen	General Experience	
51		3	4		97
52		2	3	4	99
53			3.5	3.5	100
54				4	101
55			4	3	104
56	4	3	4	2	106
57		3	4		111
58		2	4	3	112
59	3	3	3		116
60		3	4		118
61		4	3	2	121
62		4	2	3	121
63		3	2	4	125
64		3	3	3	133
65		3.5	3.5		134
66		3.5		3.5	144
67	2		4	3	152
68		4	3	2	154
69		3	4	2	156
70		2	3.5	3.5	159
71			4	3	165
72	3	3	3		166
73			3	4	172
74		3	3	3	181
75		3	3	3	189
Weight	1574	7791	10344.5	7943.5	27653
Weighted Per cent	5.7%	28.2%	37.4%	28.7%	100 %

METHOD OF RECRUITMENT

Group Nr. 4

Activity Nr.	In House Apprentice Program	In House Helper Program	Outside Hire Certified Journeyman	Outside Hire General Experience	Total Journeymen
76	2.5	2.5	2.5	2.5	195
77		4	3	2	197
78			3.5	3.5	198
79		3	4	2	199
80			4		207
81		3		4	209
82	2	3	4	1	209
83	4	2	3	1	209
84			3.5	3.5	212
85	3	2	1	4	232
86			4	3	234
87		3	2	4	250
88		3	4	2	250
89	4	2	3	1	264
90		2	4	3	278
91		4	2	3	329
92	1	4	3	2	338
93	2.5	2.5	2.5	2.5	365
94		4	3		409
95	1	2	3	4	425
96	2.5	2.5	2.5	2.5	443
97	2	3	4		444
98	2	3.5	3.5		490
99	3	3	4		513
100		2	4	1	705
Weight	10305.5	19962.5	24729.5	13284.5	68282
Weighted Per cent	15.1%	29.2%	36.2%	19.5%	100 %

TRADE CLASSIFICATIONS REPORTED

1. Electrician
2. Equipment Electrician
3. Electrical Mechanic
4. Armature Winder
5. Electrician, Power Plant
6. Power Plant Controlman
7. Power Plant Controlman (H.P.)
8. Power Plant Controlman (L.P.)
9. Diesel Electric Controlman
10. Electrician, Lineman
11. Electrician, Lineman, Telephone
12. MHE Electrical Mechanic
13. Electronics Mechanic
14. Electronics Equipment Repairman
15. Electrician, Communications
16. Radio Mechanic
17. Electrician, Telephone
18. Electrician, Teletype
19. Carpenter
20. Roofer
21. Joiner
22. Wharfbuilder
23. Cabinetmaker
24. Wood and Plaster Worker
25. Linoleum Layer
26. Glazier
27. Saw Filer
28. Upholsterer
29. Sailmaker
30. Mason
31. Plasterer
32. Asphalt and Cement Worker
33. Cement Worker
34. Paver
35. Moulder
36. Painter
37. Letterer and Graniner
38. Sign Painter
39. Painter, Coach
40. Sand Blaster
41. Plumber
42. Water System Controlman
43. Water Plant Operator
44. Sewage System Operator
45. Automotive Mechanic
46. Automotive Mechanic, Accessories
47. Refrigeration and Air Conditioning Mechanic
48. Refrigeration Mechanic

49. Air Conditioning Mechanic
50. Dehumidification Mechanic
51. Refrigeration and Air Conditioning Operator
52. Refrigeration Plant Operator
53. Pipefitter
54. Sprinkler System Mechanic
55. Pipe Coverer and Insulator
56. Heating Plant Operator
57. Heating Plant Operator (H.P.)
58. Gas Heating Equipment Operator
59. Boiler Tender
60. Machinist
61. Toolmaker
62. Model Builder, Metal
63. Machine Parts Assembler
64. Machinist, Automotive
65. Sheetmetal Worker
66. Automotive Mechanic, Body and Fender
67. Boiler Maker
68. Iron Worker
69. Heavy Duty Equipment Operator
70. Engine Equipment Operator and Mechanic
71. Diesel Engine Mechanic
72. Welder, Combination
73. Welder
74. Blacksmith
75. Heat Treater
76. Maintenance Man
77. Millwright
78. Engineman (Hoist and Portable)
79. Rigger
80. Rigger, Antenna
81. Maintenance Mechanic
82. Machinist, Maintenance
83. Galley Equipment Mechanic
84. Pumping Equipment Mechanic
85. Gas Heating Equipment Mechanic
86. Heating Equipment Mechanic
87. Outside Machinist
88. Tool Room Mechanic
89. Elevator Mechanic
90. Office Machine Repairman
91. Central Office Repairman
92. Instrument Mechanic
93. Instrument Mechanic, Electric
94. Electric Clock, Repairman
95. Machine Test Operating Mechanic
96. Locksmith

97. Pest Control Equipment Operator
98. Exterminator
99. Gardner
100. Foreman (various trades)*
101. Chief Quarterman (various trades)*
102. Quarterman (various trades)*
103. Leadingman (various trades)*
104. Head (various trades)*
105. Shop Planner (various trades)*
106. Maintenance Scheduler*
107. Automotive Inspector
108. Inspector (various trades)*
109. Planner Estimator (various trades)*
110. Laborer*
111. Trackman*
112. Driver*
113. Truck Driver*
114. Truck Driver, Heavy*

* Reported on three or less questionnaires through error.

DISTRIBUTION OF JOURNEYMEN BY ACTIVITY - GROUP NR. 1

Activity Nr.	Carpenter	Painter	Plumber	Electrician	Maintenance Man	Refer. & A/C Mech.	Automotive Mech.	Pipefitter	Machinist	Sheetmetal Worker	Enginemen (H & P)	Welder	Heavy Duty Equip.Mech	Machinist Maintenance	Rigger
1	5	1	2	1											
2	3	2	1	3								1			
3		1		1			4				3				
4	3	2	2	3	1	1				1					
5	2	2	3	1	2	1									
6	3		3	3	1								6		
7	2	2	2	2	4	2							2		
8	2	2	2	4		2	7								
9	6	6	3	4						1					
10	3	3	3	2		6	1								
11	1	3		5		2	3	7		1					
12	3	1	3	7					8			2			1
13	4	3	6	9	1				2	1					
14	5	2	5	5											
15	4	3	2	6	6	1		5							
16	5	3	6	8	1	1	5								
17	3	1	1	8					2				10		2
18	4	6		4	2	2		5		1		1		2	
19	5	3	5	3	1		4		4	3					1
20	7	4	6	10	1							2		3	3
21	3	4	4	7		1	3				2		1		
22	10	6	5	2		3		2		1		1			
23	5	4	5	4											
24	10	5	9	13											
25	5	6	4	5	12					1					2
	103	75	82	120	32	22	27	19	16	10	5	7	19	5	9
%	15.9	11.6	12.7	18.6	5.0	3.4	4.2	2.9	2.5	1.5	0.8	1.1	2.9	0.8	1.4

DISTRIBUTION OF JOURNEYMEN BY ACTIVITY - GROUP NR. 2

Activity Nr.	Carpenter	Painter	Plumber	Electrician	Maintenance Man	Refer. & A/C Mech.	Automotive Mech.	Pipefitter	Machinist	Sheetmetal Worker	Engineman (H &P)	Welder	Heavy Duty Equip.Mech.	Machinist Maintenance	Rigger
26		4	2	9	1	3		1		1					
27	5	3	3	4											
28	5	4	6	7		1		1	3	1		1			
29	8	5	7	6	2	1						2			
30	6	4	4	6	3		6					1			
31	7	2	7	7		2			3	1		3			
32	4	4		4		4			4	4		4			
33	9	5		4		6	12	4				1			2
34	4	6	4	3	2	1	2	4				1			
35	8	3	11	8	3								1		
36	5	3		5		4		5	1	2		1			
37	10	7	12	18	8		11			3		1	14		10
38	8	8	5	8			5			3	1	1			1
39	9	8	8	6		1			1	3		1			
40	5	2	2	14		2		6	15	5		2			
41	8	7	5	9		4	7	2		2		2	2	1	
42	6	7	8	17		7	5	4		1					5
43	12	9	9	12		2			2	3		2		6	
44	17	8	11	13									1		
45	4	6	4	7	2	2	2	4	3	1		1	3	5	
46	16	17	5	18	4	6				3		4			
47	5	4	2	17	11		2		17	4	2		7	1	7
48	6	9	4	5		8	9		2	1	2	1			
49	13	9	8	20		12	16	2	7	2		1			
50	18	10	15	20			11	9	11	1					
	198	154	142	247	36	66	83	34	75	41	5	29	28	13	25
%	13.3	10.3	9.5	16.6	2.4	4.4	5.6	2.3	5.0	2.8	0.3	1.9	1.9	0.9	1.7

DISTRIBUTION OF JOURNEYMEN BY ACTIVITY - GROUP NR. 3

Activity Nr.	Carpenter	Painter	Plumber	Electrician	Maintenance Man	Refer. & A/C Mech.	Automotive Mech.	Pipefitter	Machinist	Sheetmetal Worker	Engineman (H & P)	Welder	Heavy Duty Equip. Mech	Machinist Maintenance	Rigger
51	7	6	9	12		1	8	1	1	3		4	5	1	
52	15	15	9	13		9		5	5	4		1			
53	9	12		20					3	3		3			
54	19	26	19	20	4				4	6		3			
55	7	3	7	16	1	2			8	1		1			
56	26	17	28	22					4			4		5	
57	8	8	14	12		8									
58	5	5	6	21	22	2				2		2			3
59	22	22	13	30	3	9		8		3					1
60	4	3	5	10	5	6	14	5	2	1	1	1			3
61	8	12	9	19	2										
62	20	13	9	17		10		14	2	3		3			
63	15	11	12	27	13	3	9	13						5	
64	14	9	14	16	2	1	15			1		2	5		1
65	14	11	10	10	9										
66	19	17	15	20	13	8		12	2	6		3		6	
67	20	11	15	32	1	12	1	14				2	7	11	1
68	10	8		13	1	2	7	14	2	5	8	3	9		10
69	16	9	27	19	5										
70	13	25	15	24											
71	6	2	1	16		2		8	9	3	1	7			3
72	13	10	31	37		9			2	15		8		24	
73	12	11	2	17		5	17	15	11	8		8	14	18	4
74	23	18	10	29	3	9	14	24	9	10		5	9		10
75	10	10	4	11		2	4	10	15	3		3		8	2
	335	294	284	483	84	100	89	143	79	77	10	63	49	78	38
%	10.0	8.8	8.5	14.5	2.5	3.0	2.7	4.3	2.4	2.3	0.3	1.9	1.5	2.3	1.1

DISTRIBUTION OF JOURNEYMEN BY ACTIVITY - GROUP NR. 4

Activity Nr.	Carpenter	Painter	Plumber	Electrician	Maintenance Man	Refer. & A/O Mech.	Automotive Mech.	Pipefitter	Machinist	Sheetmetal Worker	Engineman (H & P)	Welder	Heavy Duty Equip. Mech.	Machinist Maintenance	Rigger
76	33	43	14	37	1	7		9	13	3		6			
77	41	26	31	37	9										8
78	10	14	9	21	2										
79	15	13	10	16				11	16						
80	19	19	10	24		5		14	3	4	4			4	4
81	24	18	12	35	2							7			
82	21	16	15	12		4	16				11			4	
83	37	22	35	41		9	22			17					9
84	27	18	23	52	14	11	36	18		12		7		1	
85	17	31	14	36		8		11	4	6	1	5		4	3
86	15	11	10	27	2	11	27	11	7	4	14	13	16		25
87	1	28	6	27		3	7	14	6	10	1	6		5	4
88	30	26	12	24		6	11	19	2	5	2	5	3		1
89	14	40	10	27		21	18	6	14	9		6			
90	24	28	39	61	1	24				10		1			
91	35	37	40	43											
92	36	36	32	57		8	28		11	10					23
93	23	10	28	47		1	29		11	13		7			
94	75	62	46	58	13	28		26	4	11				11	
95	13	28	12	91		11	19	15	4	18	77	16	41	21	
96	12	27	12	36	2										
97	31	17	27	49	2	5	21	2		10	52		27	9	3
98	20	12	16	46	8	21	17	35	2	2		5		17	
99	37	40	35	64	6	23	39		31	14	12	12			16
100	39	69	17	110		52	56	51	42	30		20	45		16
	649	691	515	1078	62	258	346	242	170	188	174	116	132	76	112
%	8.3	8.9	6.6	13.8	0.7	3.3	4.4	3.1	2.2	2.4	2.2	1.5	1.7	1.0	1.4

APPENDIX C

SHOP TRAINING OUTLINE FOR PIPEFITTER APPRENTICES

SHOP TRAINING OUTLINE FOR PIPEFITTER APPRENTICES

Areas of Training	Total Hours	Hours Per Year of Apprenticeship			
		1st	2nd	3rd	4th
Grand Total	6400	1600	1600	1600	1600
1. Shop Indoctrination and Orientation					
a. Familiarization with shop production and personnel policies, safety and fire prevention regulations	2	2	-	-	-
b. Familiarization with location of shop facilities, equipment, and supplies	2	2	-	-	-
Area Total	4	4	-	-	-
2. Job Planning					
a. Reading and interpreting blueprints and specifications	80	20	20	20	20
b. Making templates and sketches	120	20	20	20	60
c. Preparatory job planning	40	5	5	10	20
d. Trade coordination	40	-	10	10	20
Area Total	280	45	55	60	120
3. Hand, Portable, and Power Tools					
a. Cutting pipe	100	25	25	25	25
b. Threading pipe	200	50	50	50	50
c. Bending pipe	200	50	50	50	50
d. Operation drill press and grinder	150	40	30	40	40
e. Maintaining and repairing tools and equipment	150	25	35	45	45
Area Total	800	190	190	210	210
4. General Shopwork					
a. Fabricate pipe assemblies	276	78	66	66	66
b. Test valves, gauges, and assemblies	80	20	20	20	20
c. Repair furnaces	40	-	10	10	20
d. Repair traps and valves	40	-	20	10	10
Area Total	436	98	116	106	116

5. Chemical Systems					
a. Installing and maintaining acid lines and valves	200	50	50	50	50
b. Installing and maintaining pyro lines and valves	220	80	60	60	20
c. Installing and maintaining ether, alcohol, and ammonia piping, valves, and gauges	180	70	40	35	35
d. Installing and maintaining soda wash system	80	20	20	20	20
Area Total	680	220	170	165	125
6. Hydraulic Systems					
a. Installing and maintaining piping, valves, and gauges of accumulators and presses	240	60	60	60	60
b. Installing and maintaining hydraulic testing equipment	120	30	30	30	30
Area Total	360	90	90	90	90
7. Sewage Systems					
a. Installing and maintaining lines from buildings to main sewers	240	40	60	70	70
b. Repairing valves, piping, and chlorinator in sewage disposal plant	80	20	20	20	20
c. Clearing all waste lines	160	40	40	40	40
Area Total	480	100	120	130	130
8. Fire Protection Systems					
a. Installing and repairing fire mains, plugs, and valves	220	50	55	55	60
b. Repairing, testing, and adjusting sprinkler system	40	-	-	10	30
c. Repairing pumps	60	15	15	15	15
d. Making wet taps for connections	40	10	10	10	10
Area Total	360	75	80	90	115

9. Fresh Water Systems					
a. Installing and repairing lines and valves to domestic and industrial buildings	228	44	44	70	70
b. Repairing pumps	60	15	15	15	15
c. Making wet taps for new connections	24	-	8	8	8
d. Connecting supply lines to plumbing	24	6	6	6	6
e. Connecting supply lines to industrial equipment	120	15	30	25	50
f. Installing and repairing drinking fountains	24	6	6	6	6
Area Total	480	86	109	130	155
10. Steam Distribution					
a. Maintaining valves, piping, and gauges to boilers, generators, and pumps	380	90	95	95	100
b. Fabricating, installing, and repairing steam lines, valves, gauges, traps, and assemblies	420	140	120	80	80
Area Total	800	230	215	175	180
11. Air Distribution					
a. Installing and maintaining special pressure and vacuum assemblies	100	25	25	25	25
b. Installing and maintaining air reservoirs	40	10	10	10	10
c. Making connections to equipment	60	15	15	15	15
Area Total	200	50	50	50	50
12. Laboratory Maintenance					
a. Installing and maintaining special pressure and vacuum assemblies	160	60	25	20	55
b. Connecting and disconnecting heating, refrigeration, and other testing equipment	240	80	25	60	75
Area Total	400	140	50	80	130

13. Domestic And Industrial Heating And Air Conditioning					
a. Installing and maintaining steam unit heaters and Radiators	120	30	15	44	31
b. Installing and maintaining hot water furnaces, radiators, and piping	140	32	30	50	28
c. Installing and maintaining air conditioners	140	30	20	50	40
Area Total	400	92	65	144	99
14. Suggested Allied Trade Experiences					
a. Plumbing	200	100	50	50	-
b. Welding and brazing	100	-	60	40	-
c. Sheet metal working	100	-	100	-	-
Area Total	400	100	210	90	-

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